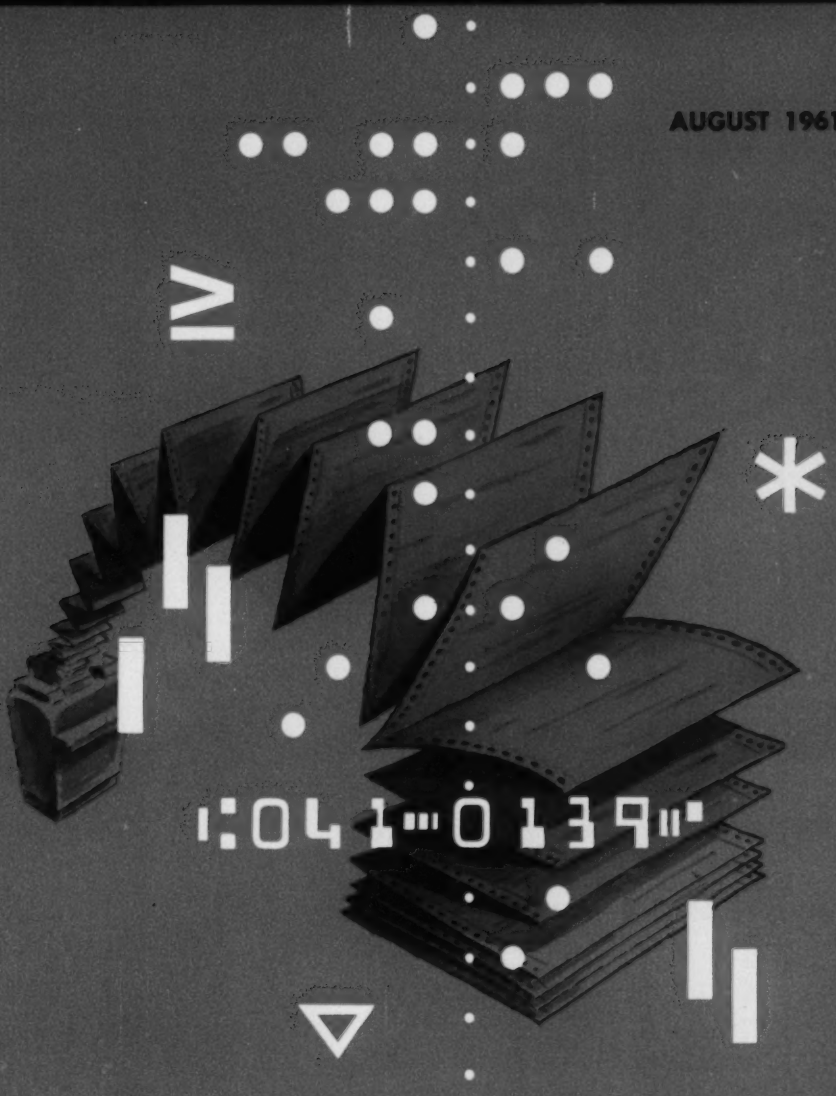
AUTOMATION

AUGUST 1961



Data - the Crucial Element

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Handling and Baling Scrap
- Air Supply Maintenance
- Intermittent Feeding of Metal Webs
- Adjustable Speed Hydraulic Drives

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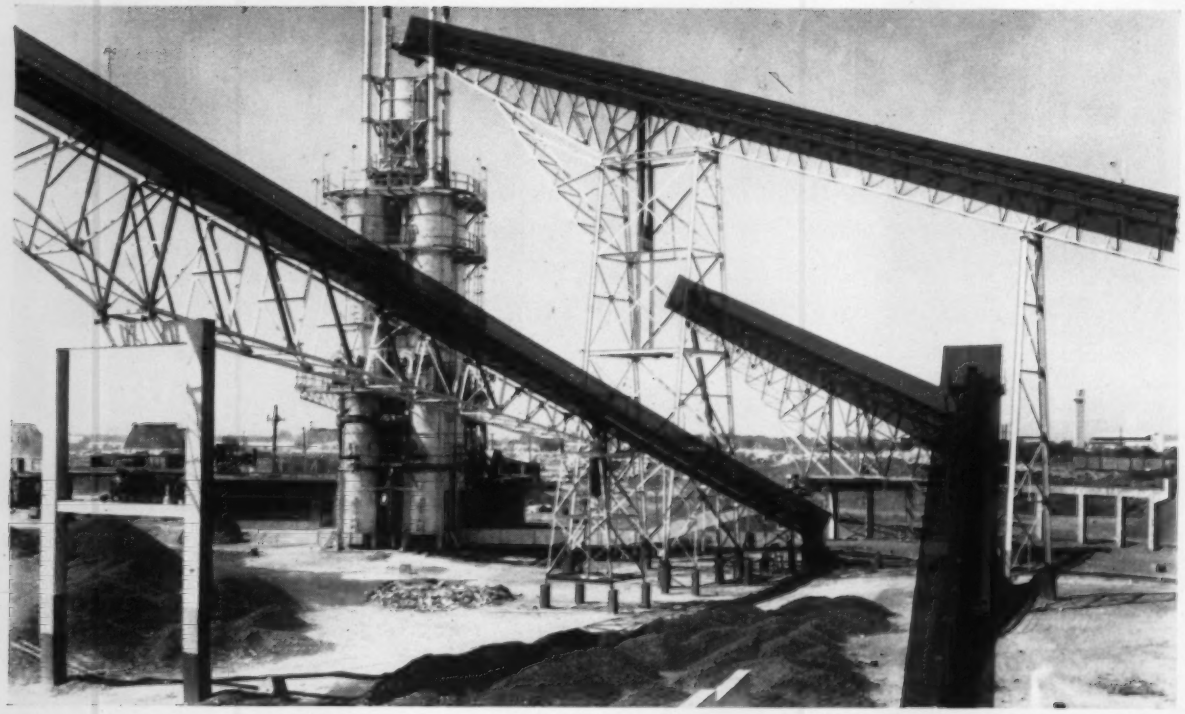
A PENTON PUBLICATION



Rotating stacker belt

PLANET SYSTEM CONVEYS, SORTS AND STORES 150 TONS OF IRON ORE PER HOUR . . .

another example of Planet Versatility . . .

Near Monterrey, Mexico, stands the maze of conveyors partially shown above. This system's job is to convey 150 tons of iron ore per hour through crushing operations to segregated storage areas, then reclaim it by grade. And it is one of many examples of PV—*Planet Versatility* . . . Planet Corporation's ability to find efficient solutions to production, materials handling or automation problems, big or small.

From a pit where the ore is crushed, a 24-inch trough-belt conveyor carries it to a secondary crusher. Here the rock is reduced and screened. Chunks larger than 1-inch diameter are recirculated, the fines are separated and transferred to a special stacker, and the usable ore is conveyed to a rotating stacker belt which piles it according to grade. To reclaim the ore, Planet constructed a series of tunnels under the storage area. The tunnels allow selection of the grade of ore to be conveyed to the retort in which sponge iron is made.

Let Planet demonstrate how its versatile engineering skill and production and erection know-how can solve your handling problems. Call or write . . . you'll find *it pays to plan with Planet.*

Sales Offices in Principal Cities in the United States and Mexico

PLANET CORPORATION

1810 SUNSET AVENUE • LANSING, MICHIGAN

- Engineered Handling Systems
- Automation Equipment
- Mill & Foundry Handling Equipment

011

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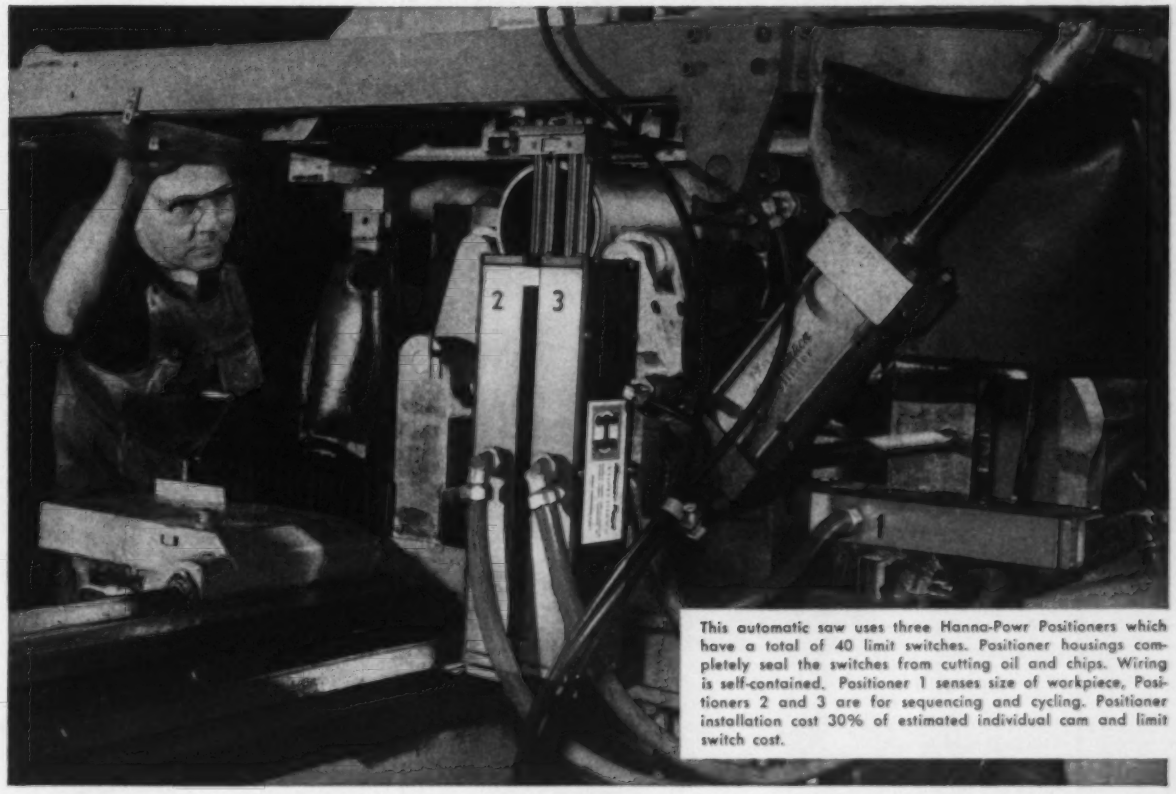


This automatic saw uses three Hanna-Powr Positioners which have a total of 40 limit switches. Positioner housings completely seal the switches from cutting oil and chips. Wiring is self-contained. Positioner 1 senses size of workpiece, Positioners 2 and 3 are for sequencing and cycling. Positioner installation cost 30% of estimated individual cam and limit switch cost.

Start a cam and limit switch COST REDUCTION PROGRAM!

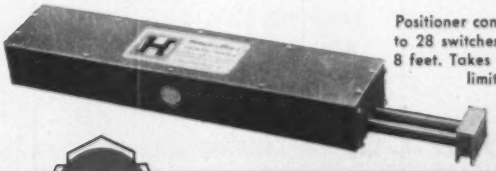
You can cut cam and limit switch costs up to 70% by using the Hanna-Powr Positioner — a compact, dust and water-tight housing containing cam rods and limit switches.

Because the Positioner is a pre-engineered assembly, it saves time used in designing special cams and mountings. Installation costs are cut, too, because it is only necessary to mount one box (4 screws) rather than individual switches and cams. Wiring is greatly simplified. The Positioner housing serves as a junction box—one conduit connection does it.

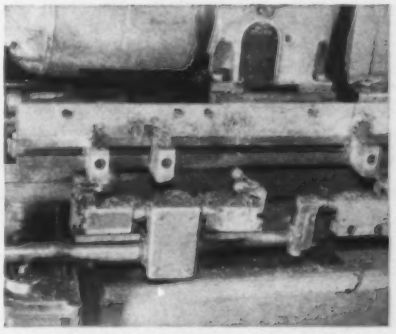
The switches can be moved easily and locked quickly in place after installation. This speeds set-up time for new jobs and makes pre-calculation of stops unnecessary. Safety is another big advantage—the switches cannot be tripped accidentally.

In addition to lower initial costs —maintenance, replacement, and down-time costs are cut. Switches last longer due to the protection (from dirt, chips, fluids and damage) afforded by the sturdy, extruded aluminum housing.

Use Hanna-Powr Positioners for cycling, sequencing, positioning, sensing and indicating. Many are in use and have been thoroughly tested in a variety of applications. It's a practical approach to automation.



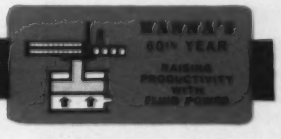
Positioner containing switches and cam rods. Up to 28 switches per foot of travel. Any travel to 8 feet. Takes standard miniature or heavy duty limit switches, single or double throw.



Examine your cam and limit switch costs. $35 to $75 per switch is the cost companies have fixed for designing, machining, installing, wiring, and adjusting limit switches and cams. This photo shows a typical high cost installation where oil, chips and accidental damage cause high failure rates and increased maintenance costs.

Write for complete catalog or consult Sweets' Product Design File section 9A/HA. Your Hanna Representative will also give you complete information—see the yellow pages under cylinders.

Hanna Engineering Works



1753 Elston Ave., Chicago 22, Illinois
AIR AND HYDRAULIC CYLINDERS, VALVES, POSITIONERS

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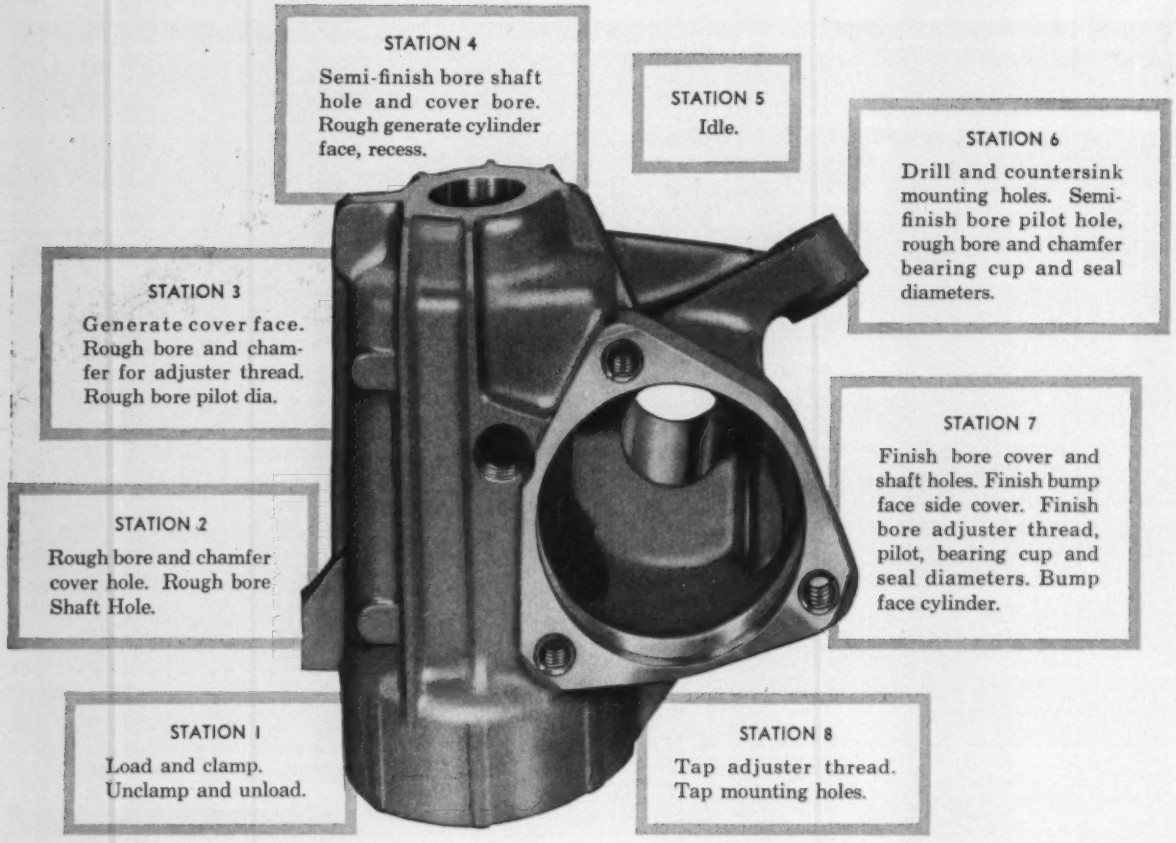
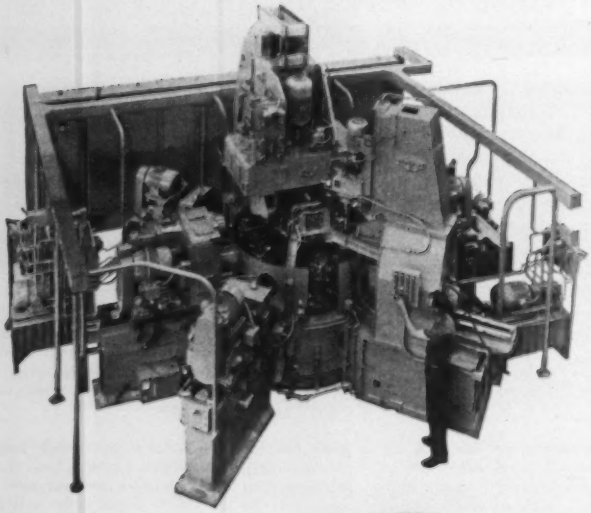

STATION 4
Semi-finish bore shaft hole and cover bore. Rough generate cylinder face, recess.
STATION 5
Idle.
STATION 6
Drill and countersink mounting holes. Semi-finish bore pilot hole, rough bore and chamfer bearing cup and seal diameters.
STATION 3
Generate cover face. Rough bore and chamfer for adjuster thread. Rough bore pilot dia.
STATION 7
Finish bore cover and shaft holes. Finish bump face side cover. Finish bore adjuster thread, pilot, bearing cup and seal diameters. Bump face cylinder.
STATION 2
Rough bore and chamfer cover hole. Rough bore Shaft Hole.
STATION 1
Load and clamp. Unclamp and unload.
STATION 8
Tap adjuster thread. Tap mounting holes.

153 Aluminum Steering Gear Housings per hour

automatically processed on this GREENLEE Machine



This Greenlee 8-Station Horizontal and Vertical Spindle Machine is establishing some excellent performance records for a leading automotive manufacturer. The 52 inch table carries 8 work fixtures. Each has power clamping. To insure rigidity and accuracy, the table is clamped hydraulically metal to metal. Indexing is fully automatic. Cycle time is 23.5 seconds. Like all Greenlee machines it's built for long, continuous service. Can be modified economically if desired. Have our representative give you complete information.

MACHINES DESIGNED
WITH THE FUTURE IN MIND

GREENLEE BROS. & CO.

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TRANSFER MACHINES • SPECIAL MACHINES • AUTOMATIC BAR MACHINES • WOODWORKING MACHINES AND TOOLS
DIE CASTING MACHINES • TRIM PRESSES • HYDRAULIC AND HAND TOOLS • COMMERCIAL CASTINGS

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The Magazine of Automatic Manufacturing Operations

AUTOMATION®

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AUGUST 1961
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Penton Building, Cleveland 13, Ohio

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automation outlook

HELP NEEDED

THE newly created Labor Dept. Advisory Committee on Automation and Manpower admittedly faces some mighty complex problems. Some perhaps are unresolvable. Others, hopefully the major ones, can at least be reduced substantially in their breadth and effects with better understanding made possible through serious study.

Our first meeting has resulted in highlighting some basic aspects to be recognized and evaluated. Four major programs are to be studied. *Information* needed will involve collection and analysis of data on current and expected technological change and its over-all effects. Thereby government, labor, management, and education will have up-to-date intelligence on automation and other technological influences. This basic information collected requires *communication* not only through publications but through direct national and community clearinghouse activity. Where problems are found, the possibility of *mitigation* must be considered to reduce unnecessary adverse impact (not only to individuals but to communities and the economy) through improved employment services and expanded education, training, retraining, skill development, and promotion of workforce mobility.

A final area involves *prevention* of future impact from rapid change in employment demands as economic growth continues. Here the concern is youth and the provision of better guidance, counseling, and testing to obviate the creation of future generations of jobless in a world demanding more and more education and higher skills.

Most emphatically the full co-operation of industry leaders is needed to make any such effort successful. Surely, to guarantee that ultimately such programming does not degenerate into mere support of the indolent, it is imperative that active and interested industry participation be developed. In a free competitive economy such as ours, no act or committee action can achieve much in the way of desirable results without stimulation of individual understanding and interest.

As a starter we recommend you read the new bill "Manpower Development and Training Act of 1961" proposed by Secretary Goldberg and let us have the benefit of your considered comment. Write your representatives in Congress.

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NEW EQUIPMENT DIGEST

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BPA NBP

Fluid Power news

OILGEAR 40 Years of Fluid Power

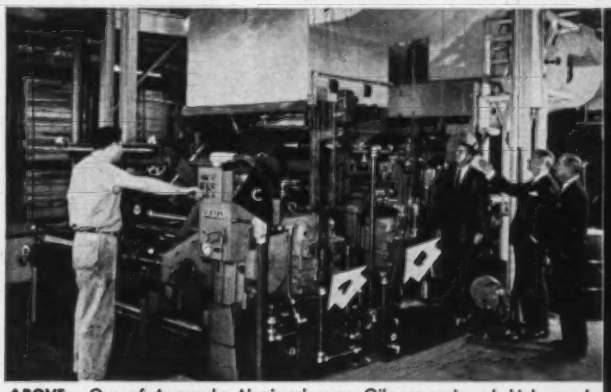
Report No. 11,806 From Oilgear *Application-Engineering* Files

HOW OILGEAR HEAVY-DUTY *Any-Speed HYTAC** DRIVE SYSTEMS ON *Anaconda's* NEW FOIL LAMINATING AND COATING MACHINES HELP SPEED PRODUCTION—CUT COSTS

USER: *The Anaconda Aluminum Company, Louisville, Kentucky, Fair Lawn, New Jersey, Terre Haute, Indiana*
(Machine Builder — New Era Manufacturing Company, Hawthorne, New Jersey — successor to Meisel Press Manufacturing Company, Boston, Mass.)

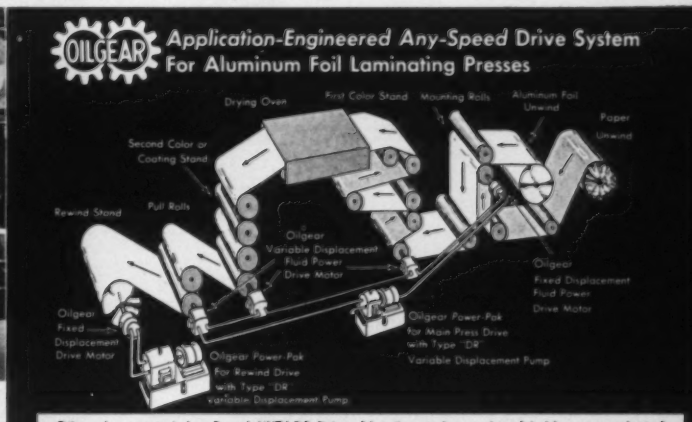
PROBLEM: Main and Rewind Drive Systems for two, new, high-speed laminators to bond aluminum foil as thin as 0.0002″ to paper stock ranging from 15-lb tissue to 0.020″ carton and food board. In addition to laminating, these "presses" must simultaneously coat and/or color the foil.

REQUIREMENTS: 1. Accurate, wide range, dependable tension control to accommodate *Anaconda's* complete range of laminating foils and paper stock. 2. Infinitely variable, stepless speed range from 0 to 1000 fpm—capable of an optimum, continuous 850 fpm running speed. 3. Maintain tension accurately in "stall" condition indefinitely without overheating—and then pick up speed smoothly and quickly without snapping the sometimes fragile web. 4. Reduce costs through reduction of scrap, repair parts inventories, and machine downtime . . . operate at nearly three times former production speeds. 5. Must be: compact, to conserve valuable floor space; economical on electric power input; capable of continuous, three-shift operation.



ABOVE: One of Anaconda Aluminum's new, Oilgear-equipped, high-speed foil laminating and coating presses—rewind end—as installed at their Louisville, Kentucky, Laminating Plant. Roll cores—8¾″ dia. . . . web width—from 23″ to 52″ . . . roll diameters—to 60″ . . . roll weights—to 4500-lb. Tension range —from ½-lb/in. to 4-lb/in. depending on weight of lamination being processed. Arrows (A), (B)—Oilgear Variable Displacement Drive Pumps. Arrow (C)—one of two pushbutton control stations at opposite ends of the press—3 emergency "stop" buttons are located at other positions.

SOLUTION: Oilgear *Any-Speed HYTAC** Main and Rewind Drive and Tension Control Systems—as symbolized in the schematic sketch—above right. These compact, heavy-duty systems have successfully met or exceeded all originally specified requirements in continuous, three-shift, high-speed operation. Oilgear Drives were selected for these new machines because of: 1. The enviable record of maintenance-free long-life in several Anaconda Aluminum Plants. For example—six out of seven original, 300-fpm laminating presses at Louisville are Oilgear-equipped . . . two operating continuously since 1946. These 14-year-old drives—and two others—*have NEVER required maintenance other than oil changes and an occasional drive shaft seal.* The other two Oilgear Drives—installed in 1948—were disassembled three years ago merely for a preventive maintenance check—haven't been "touched" since. 2. Oilgear's accurate, dependable tension and speed control over a wide range—for smooth, precise, trouble-free operation on Anaconda's *entire range* of laminating stocks. 3. Space saving—Oilgear Drives occupy less floor space . . . do not require high-speed blowers for cooling—can hold stall-speed indefinitely without overheating. 4. Economy—in electrical power input, maintenance, virtually eliminate costly machine downtime and spare parts inventories . . . and in many cases—at lower installed cost.


OILGEAR
Application-Engineered Any-Speed Drive System
For Aluminum Foil Laminating Presses
Drying Oven
First Color Stand
Mounting Rolls
Aluminum Foil Unwind
Paper Unwind
Second Color or Coating Stand
Rewind Stand
Pull Rolls
Oilgear Variable Displacement Fluid Power Drive Motor
Oilgear Fixed Displacement Fluid Power Drive Motor
Oilgear Fixed Displacement Drive Motor
Oilgear Power-Pak For Rewind Drive with Type "DR" Variable Displacement Pump
Oilgear Power-Pak for Main Press Drive with Type "DR" Variable Displacement Pump

Oilgear's patented *Any-Speed HYTAC** Drives (details not shown above) hold any preselected speed within ±0.1% under constant torque loads—within ±0.5% regardless of load, electric power variations, or temperature and viscosity changes . . . provide cushioned starting, remote jogging and threading . . . smooth, even let-off or build-up tensions . . . constant torque . . . adjustable tension . . . hydrodynamic braking. Applied to center shaft winders, *Any-Speed HYTAC** Drives automatically sense and compensate for changes in overall machine speed, and can automatically provide constant, adjustable, or tapering tension over a 20:1 winding range without dancer or follower rolls.

*HYTAC—A registered Oilgear Trademark

Unbelievable?—Not to Oilgear Users! There are case histories upon case histories on file of machines equipped with *Application-Engineered Oilgear Drive Systems* that are rolling along—efficiently, quietly—with over 20 years of trouble- and maintenance-free service! Some additional *installation-proved* reasons . . . the greater accuracy, precision control of speeds, torques, tensions . . . new economies of operation, installation, and valuable floor space . . . are why more and more Oilgear users in the paper, printing and converting, food and beverage, marine, chemical, pharmaceutical, primary metals, metalworking, textile, rubber, military, and other industries all agree that . . .

for the lowest cost per year . . . it's OILGEAR!

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY
Application-Engineered Fluid Power Systems
1598 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN
Phone: Mitchell 5-6715 . . . Direct Distance Dialing Code — 414

A New Generation of

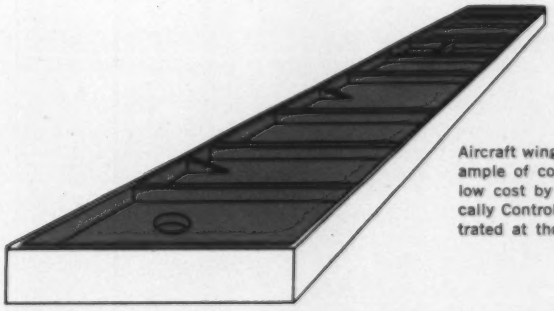
Designed for numerically controlled milling. This new CINCINNATI 36″ x 120″ Bridge-Type Profile and Contour Milling Machine automatically mills the pockets of an aircraft wing inner panel beam. The machine is one of several built to perform a variety of aerospace and general purpose milling operations.

DESIGNERS AND BUILDERS OF SPECIAL MACHINES • HORIZONTAL BROACHING MACHINES •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

Machines built by CINCINNATI | SPECIAL MACHINE DIVISION

. . . has everything required for numerically controlled milling



Aircraft wing inner panel beam, an example of complex parts machined at low cost by the CINCINNATI Numerically Controlled Milling Machine illustrated at the left.

Numerical control is the boss; it tells the machine exactly what to do at a particular time. But to perform the task accurately, the machine must be equipped to follow instructions without benefit of a highly skilled operator. Cincinnati's Special Machine Division blends all requirements for ultra-modern metalworking equipment in the new Bridge-Type Profile and Contour Milling Machines. They're a new generation of machines, new from the ground up; designed specifically for numerically controlled milling on a variety of parts made of aluminum, titanium, steel and the new "exotic" materials.

The machine is a closed cantilever construction, assuring extra rigidity throughout, to give you full potential of the numerical control system.

Constant speed hydraulic motor drive for the spindle provides full torque throughout entire range of speeds.

Wide range of spindle speeds (in 24 or 26 steps) and feeds (¼ to 100 ipm), allows complete freedom in changing from one basic metal to another.

"Building Block" construction gives you a choice of several table widths and any practical table travel starting at 48″.

Every type of equipment built by Cincinnati Milling's Special Machine Division is considered as a completely coordinated production unit capable of reducing costs, machining an "impossible" job and/or improving quality. Our specialists want to know about your metalworking problems. May we hear from you?

COMPLETELY AUTOMATED PRODUCTION LINES

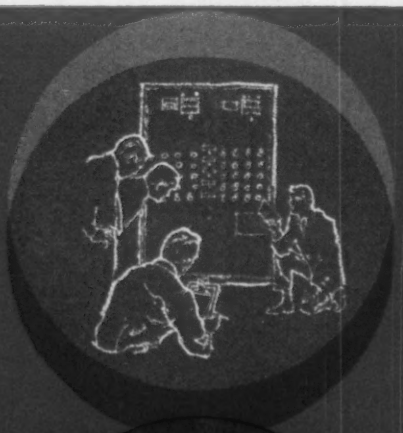
CINCINNATI®
SPECIAL MACHINE DIVISION

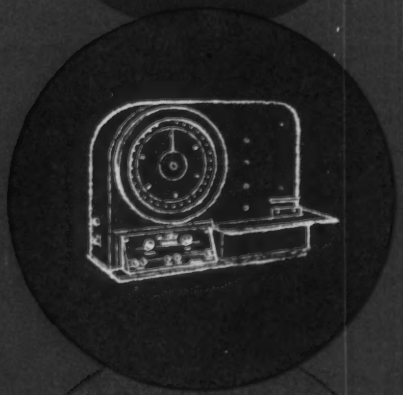
Circle 656 on Page 35

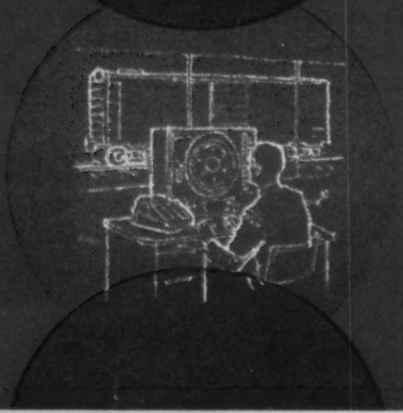
Have you analyzed your weighing operations lately? Weighing of raw materials, goods in process and finished products is big business. And while you've probably automated other areas, you may not realize what Fairbanks-Morse Electronics Weighing can do for you. ● Chances are your present weighing operation lends itself to the speed and efficiency of an F-M Electronic System. You will realize impressive savings in time, labor and material... money savings that can add substantially to your profits! ● Fairbanks, Morse knows the weighing business—we've been in it for 131 years! We've pioneered precision weighing instruments of all types, and we are the leaders in the ever-expanding field of electronic weighing. To meet the need for fast, modern weighing of any liquid or solid, Fairbanks, Morse offers a wide range of standard electronic weighing systems plus custom-designed installations. ● The F-M Batchetron, for example, electronically weighs and batches a number of liquids or solids—in sequence or simultaneously—by means of manual or punched card control. Other F-M Electronic systems quickly weigh trucks and railroad cars. In each of these cases you can readily see the obvious savings in time . . . and in money. ● If weighing plays an important part in your operation, you will profit from more information about F-M electronic weighing systems. Please write: **Electronics Division; Fairbanks, Morse & Co.; 100 Electra Lane; East Station, Yonkers, New York.**

ELECTRONICS DIVISION
FAIRBANKS MORSE
A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY

A MESSAGE TO MANAGEMENT FROM FAIRBANKS-MORSE ELECTRONICS DIVISION...







Series 600 Batchetron
Weighs out pre-set amounts of any material used in batching systems. High speed action insures positive cut off of ingredient flow. Improved electronic weight sensing circuit provides long, accurate trouble-free service.

Model CR
Versatile weighing and printing instrument for a wide variety of applications. Location convenience—this instrument can be placed within a radius of 500 feet from scale platform, thus offering weight records at a central plant.

Model Q—High Speed Weigher
Maximum speed—maximum accuracy for weighing materials in motion. Equipped with read-out feature and built-in memory, to transmit weight records into the most modern computers, printing devices, tape and card punch machines.

NEW DIMENSIONS IN ELECTRONIC DEVICES

Circle 657 on Page 33

AUTOMATION news

Today's events and developments in the field of automation

Machine Tools Programmed by Word Descriptions of Workpieces

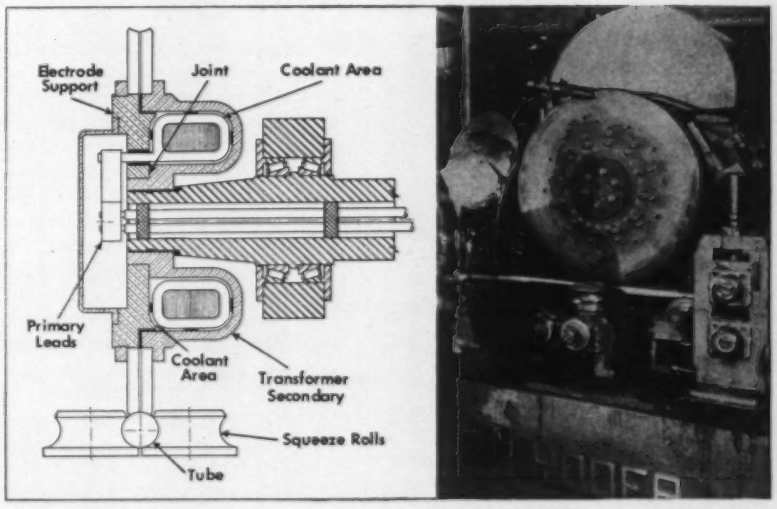
PREPARATION of control instructions for numerically controlled machine tools is simplified by a new programming method introduced by International Business Machines Corp. The new technique is the first to enable a user to generate detailed control instructions by describing whole areas of a three-dimensional workpiece with a few words. Called Autopromt (for Automatic Programming of Machine Tools), the system allows the part programmer to describe surfaces of the workpiece with a vocabulary of 110 English words. Using the programmer's instructions and a master Autopromt program, a computer automatically determines tool paths and machining instructions to produce the workpiece.

Working from an engineering drawing of the part and a knowledge of the tool that will perform the machining, the part-programmer writes a series of statements in Autopromt language. Each of the constituent surfaces of the shape to be machined is described, the relationship of these surfaces to each other is defined, and the machining conditions are specified. This information is punched into cards and fed into a computer. A master Autopromt program of more than 30,000 instructions is also fed to the computer.

Under control of the master program the computer translates the English-like language of the workpiece description into suitable computer codes, simulates within itself the surfaces and boundaries to be machined and then calculates the detailed tool travel instructions for each machining region. Final output from the computer contains a complete set of numerical instructions to the machine tool. It is produced on magnetic tape and can be converted to perforated tape or punched cards depending on the numerical control equipment to be used.

The Autopromt language is made up of 110 English words, which, when coded, can be used in their entirety or can be abbreviated as long as certain key letters are retained. Words describing shapes and surfaces include: *Cone, cylinder, hyperbolic paraboloid, sphere,* and *taurus.* Words designating the relationships between surfaces include: *Angle, axis point, intersection of,* and *surface point.*

Autopromt is a development of concepts also involved in the APT system announced at Massachusetts Institute of Technology two years ago and under continuing development through the Aerospace Industries Association. In the APT system an English vocabulary is used to describe each tool path. The computing equipment then calculates successive tool positions and motions and produces the machine control instructions. When the current phase of APT development is completed it will contain the Autopromt listings. Integration of the two systems is planned as a part of the AIA program.



NEW DESIGN for electric resistance welders increases pipe production as much as 60 per cent over conventional equipment under identical power input and operating conditions. The new Type-V welder made by Yoder Co. incorporates a vapor-cooled toroidal transformer with a single-turn secondary which both increases amperes-to-weld and decreases power input requirements. With this design the usual secondary conductor system is eliminated and welding current is transmitted directly from the transformer to the electrode. Secondary conductor impedance and resulting losses are thus reduced to a minimum so that more usable current can be delivered to the work with less input power. The cooling system uses a non-toxic dielectric fluorocarbon instead of water or oil. Using an immersion system, the fluid is sealed inside the secondary case. Heat from the primary and core vaporizes the fluid and is transferred to the case as the fluid condenses. Heat is removed from the secondary case by external water used to cool the electrodes.

TWO YOUNG men have gone into business in Pittsburgh by purchasing

a $2.5 million IBM computer. The new proprietors, **George Burns** and **Joseph Brashear,** have formed Computer Oriented Research and Engineering Inc. to operate as a service bureau selling time on its computer on an hourly basis to business firms of all sizes. Financing for the venture was provided by Apollo Industries, a diversified operating company, which retains 67 per cent of the new company's common stock.

Crane System Is Program-Controlled

PROGRAM-CONTROLLED crane system has been built by General Electric Co. to move 15-ton coils in a steel mill from a coil bander to storage areas. An operator sets the controls for size of coil and storage destination and presses a button. The crane automatically moves to the pickup point, lowers, bridges forward to insert a lifting hook, and then hoists the coil. It then travels to the selected storage area, deposits the coil and returns to its homing station. Hoist, bridge, and trolley motions are under automatic control. Motion is sensed by selsyn transmitters coupled to bridge and trolley motions and to the shaft of the hoist motor through gear boxes. Each programmed motion is ordered sequentially by switching to the proper transmitter through the logic circuitry. Crane operations are regulated by Directo-Matic solid-state control equipment composed of plug-in modules. Each control function is mounted in pull-out drawers for accessibility. A preset plugboard bank within the magnetic control allows variation and adjustment of slowdown and stop points.

TRACER CONTROL conversion unit designed by Detroit Broach & Machine Co. changes standard lathes to production tracer lathes capable of handling both ferrous and nonferrous workpieces. The workpieces can range from simple axle shafts to complex configurations produced in either intermittent job-shop or long run operations. The

Ultrasonic Process Bonds Plastics

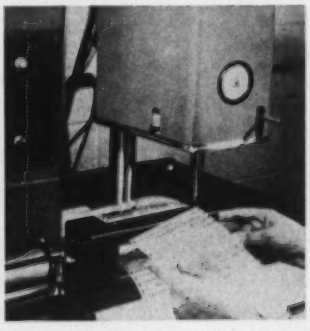
SEALING DEVICE using ultrasonic energy to weld plastic film and synthetic fabrics has been developed by Ultra Sonic Seal Inc., Div., Kleer-Vu Industries Inc. The new technique can instantly and permanently bond plastics and synthetic woven fabrics, making spot or continuous welds. The process is suitable for Mylar polyester, polyethylene, polypropylene, nylon, and vinyl films, and woven fabrics of nylon, Orlon acrylic, and Dacron polyester fibers. The sealer can be used with total material thickness ranging from one-quarter mil to 100 mils, and continuous welds have been made at speeds of 100 fpm.

Principle of operation involves the use of ultrasonic impulses. Moving at the rate of 20,000 vibrations per second, the operating tool welds plastics by releasing kinetic energy within the material to be joined. Vertical movement of the tool in contact with the plastic generates heat internally between the sandwiched layers of material, creating a natural molecular bond. Heat that is generated dissipates into the cold-mass of the anvil and the operating tool, leaving the outer surfaces of the material cool.

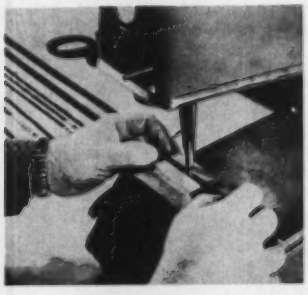
If movement of material between the tool and anvil is interrupted, the sealer will not burn the plastic and there is no danger of fire, marring, or blistering such as sometimes occur in conventional heat sealing processes. Method cleans as it seals and it will seal through contaminants such as grease, powders, paint, printing ink, and oil. The sealer can be adapted to fit into a production line, operating from a vertical or horizontal position, or it can be used for separate station production.

In one application for the Wildman-Jacquard Co., manufacturers of knitting machinery, the unit is used to seal lengths of Mylar plastic which form the pattern cards or programming belts used to control the operation of knitting machines. The belts are 5 15/16 inches wide, vary in length from 14 inches to 40 feet, and are perforated with holes which determines the design of the knitted goods. With the previous method, time to make one seam was 5½ minutes; using ultrasonic equipment, the time is cut by two-thirds.

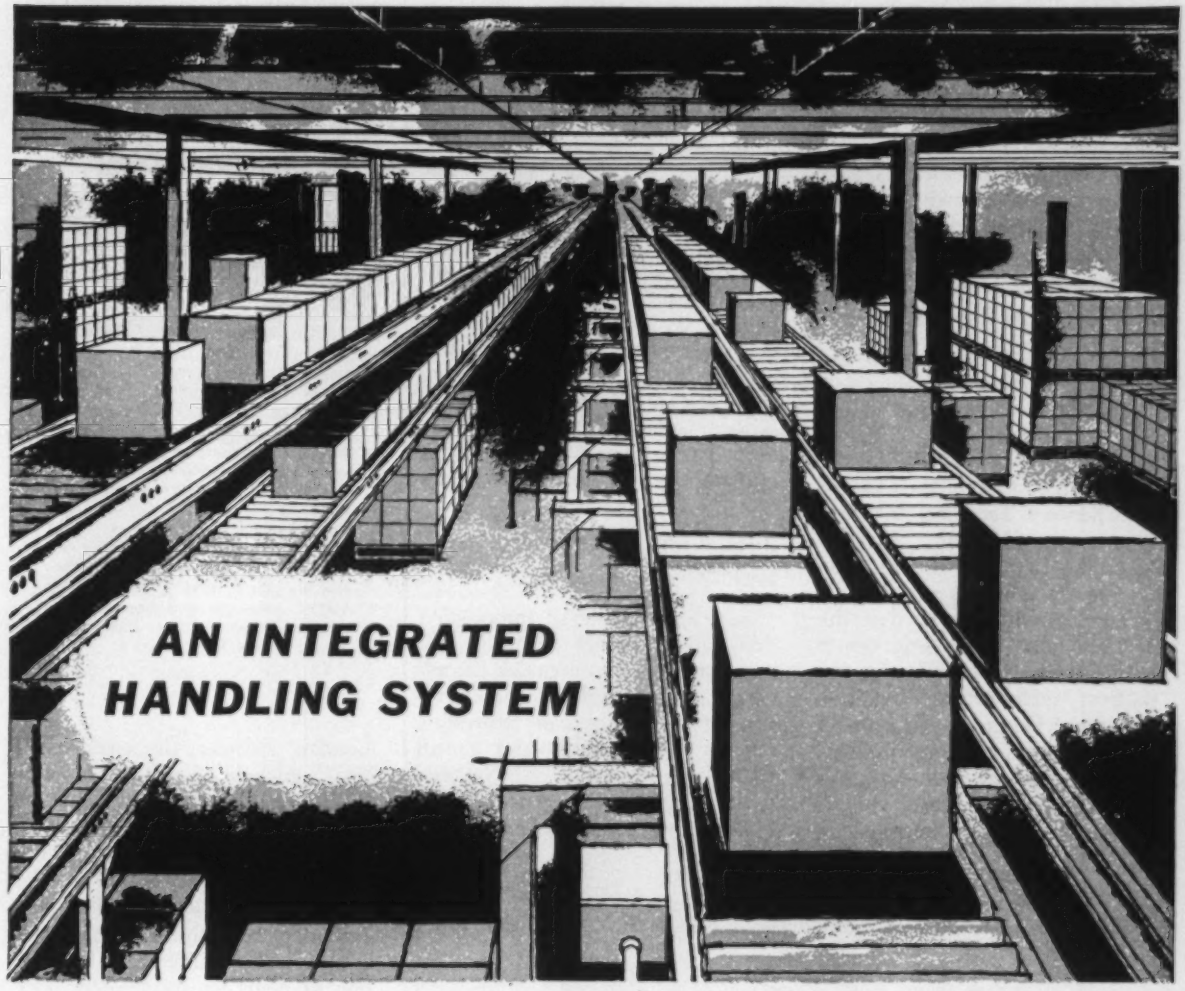
At the Union Switch & Signal Div., Westinghouse Air Brake Co., use of the sealer on Mylar belts has reduced the bonding process time by 75 per cent. Mylar belts are used for data display in the company's Readall readout instruments. Numerals or letters of the alphabet which have been imprinted on the plastic by means of a photographic process and the belts are positioned by the instruments to exhibit information. Previous process to make the belts involved five separate steps. Time involved in making the belts with the ultrasonic equipment takes about five seconds.



Mylar strip used to program knitting machines manufactured by Wildman-Jacquard Co. is secured on anvil pins prior to welding by ultrasonic method. The one-step process replaces previous method involving the use of adhesives and electric irons.



Ends of Mylar tape used for data display are bonded by sealer to form continuous loop. Belts produced this way by Union Switch & Signal Div., Westinghouse Air Brake Co. eliminate the need for adhesives and metal clips.



Overhead conveyor system saves thousands of square feet of floor space.

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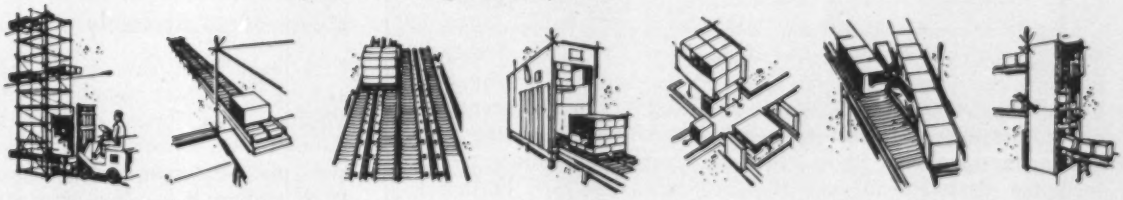
May Cut Your Package Handling Costs

It doesn't pay to buy conveyors piecemeal. You don't have to throw away your present equipment and start from scratch, either.

Alvey's experienced package handling engineers can show you how to coordinate the workable parts of your present system with new elements for faster, easier, less expensive materials handling.

Or, they can build a complete system for a new plant, or total modernization program.

Remember, it's often more profitable to cut processing and handling costs than to make new sales. Call in Alvey, and reappraise your handling methods now.



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conversion unit can be used on either horizontal or vertical machines and can generate any contour. Cost of conversion is said to run about 60 per cent less than purchase of a new special tracer.

Government to Issue More Technical Reports

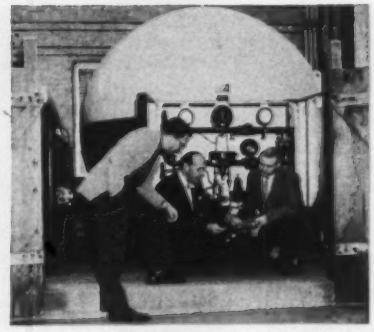
INFORMATION available to the scientific and industrial public will be doubled in volume due to cooperative operations of the Office of Technical Services (OTS) of the Department of Commerce and the Armed Services Technical Information Agency (ASTIA). Through OTS, some 15,000 to 20,000 technical reports prepared under military auspices will be offered to the public annually. OTS is the center in the Federal Government for the collection, reproduction, and sale of reports of Government-sponsored research to firms and organizations not performing contract work for the Department of Defense. ASTIA is the agency which interchanges military research and development reports among Department of Defense agencies and their contractors.

Approximately 30,000 military technical reports are annually acquired and catalogued by ASTIA, two-thirds of them unclassified. With the new program, copies of unclassified reports and catalog information will be given to OTS. The OTS periodical *U. S. Government Research Reports*, which announces available reports, will be published twice a month. It will include the unclassified portion of the ASTIA *Technical Abstract Bulletin* previously produced only for activities directly concerned with military research and development.

Information Processing Society Formed

American Federation of Information Processing Societies (AFIPS) has been established to organize the advancement and diffusion of knowledge of the information processing sciences at all levels and to all media. Delegates of the National Joint Computer Committee created the new society of societies. The founding societies, the members of NJCC, include: American Institute of Electrical Engineers, Association for Computing Machinery, and Institute of Radio Engineers. Immediate schedule calls for making an orderly transition of business and authority from the National Joint Computer Committee and formulation of plans for future joint computer conferences.

First chairman of the Governing Board of AFIPS is **Dr. Willis H. Ware** of the Computer Sciences Dept. at the Rand Corp. Interim executive committee assisting Dr. Ware includes **R. A. Imm**, International Business Machines Corp., AIEE; **Dr. Harry Huskey**, University of California, ACM; and **Dr. A. A. Cohen**, Remington Rand Univac, IRE.



LIQUID ARGON installation with capacity of 100,000 cu ft of argon is in service at Kollstan Semiconductor Elements, Div., Kollsman Instrument Corp. Kollstan uses gaseous argon in the manufacture of semiconductor devices. The new unit designed and installed by Linde Co., Div., Union Carbide Corp. stores the liquid argon at about —300 F and on demand, will automatically convert it to gas. Shown at the installation are (left to right) C. Brinton Swift, Linde; James Beeman, manufacturing manager, Kollstan; and Paul Derby, process control head, Kollstan.

West Coast Scene of ISA Conference

OVER 20,000 engineers, scientists, and others associated with instrumentation activities will converge in Los Angeles September 11-15 for the 16th annual conference and exhibit of the Instrument Society of America. The conference will be centered in the Biltmore Hotel, with the exhibit located in the Memorial Sports Arena in Exposition Park.

The conference program will consist of technical paper presentations, forums, panels, workshops, clinics, and plant tours. There will be 80 technical sessions with approximately 300 authors covering the latest progress in instrumentation technology. Co-operating with ISA in the technical conference are American Chemical Society, American Meteorological Society, California Natural Gas Association, Institute of Management Sciences, Institute of Radio Engineers, Precision Measurement Association, Southern California Metering Association and Temperature Measurement Society. Areas of discussion include aero-space, bio-medical, data handling and computation, management, measurement standards instrumentation, shock and vibration, and strain gage instrumentation. Other conference sessions include electronic instrumentation, nuclear measurements, feedback control system optimization, photographic measurements, and analysis instrumentation. Further details are available from ISA headquarters, Penn Sheraton Hotel, 530 William Penn Place, Pittsburgh 19, Pa.

To Develop Methods for Micromodule Assembly

CONTRACTS to develop mechanical means to mass assemble micromodules have been granted to Paktron Div., Illinois Tool Works, and the Microcomponents Dept., P. R. Mallory & Co. Inc., by Radio Corporation of America as part of a project for the U. S. Army Signal Corps. The microminiature electronic circuits are part of a Signal

NOW 3-AXIS NUMERICAL CONTROLS FOR B&S TURRET DRILLS

HUGHES 3-AXIS NUMERICAL CONTROLS are now available as original equipment on Brown & Sharpe turret drills. With 3-Axis control, operation is completely automated—more work at less cost. Each spindle can be programmed for multiple drill depths. Feed speeds are tape controlled. Set-up time is reduced more than sixty per cent. And—as with all Hughes Numerical Controls—jigs, fixtures and templates are eliminated. Fitting 3-Axis controls to B & S turret drills is another "first" for Hughes. And you get proven reliability through Hughes' long experience in numerical controls. Hughes' transistorized circuitry, modular construction, and photo-electric tape readers mean more "up-time," increased production and less maintenance. Hughes ULTRA-RELIABILITY adds up where it counts—in your profits.

SPECIFICATION SUMMARY

Axis controlled	X	Y	Z
Range of movement	20"	15"	9"
Accuracy	±0.001/ft.	±0.001/ft.	±0.002/ft.
Repeatability	±0.0002/ft.	±0.0002/ft.	±0.001/ft.
Position Speed (in./min.)	160"	160"	180"

Find out more about 3-Axis (or 2-Axis) Hughes Numerical Controls. Ask your B&S distributor, or write, wire, teletype (TWX INGL 4117) or call: Hughes Industrial Control Systems, Dept. No. 92-21, P.O. Box 90904, Los Angeles 45, California.

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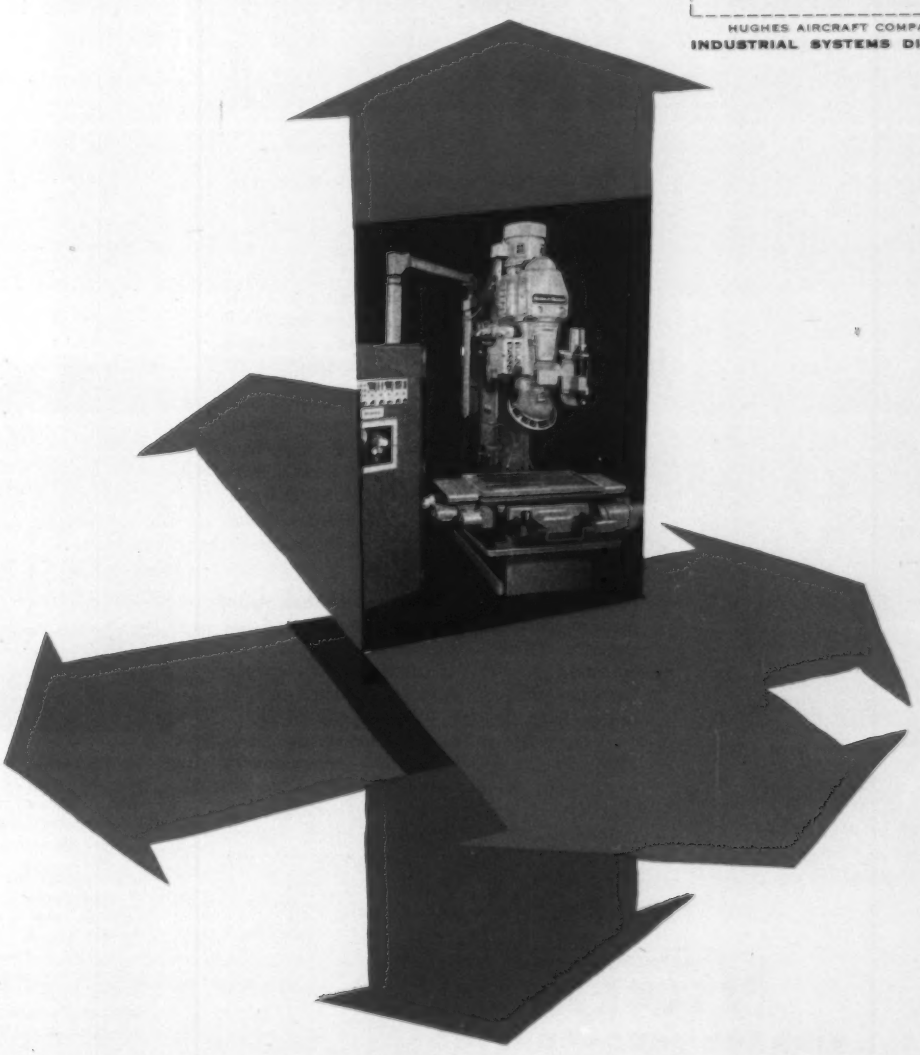
INDUSTRIAL SYSTEMS DIVISION



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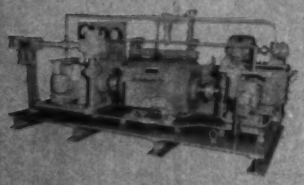
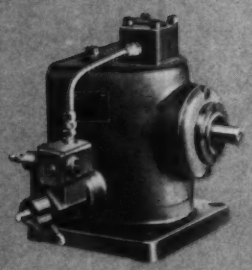
EQUIPMENT BUILT BY AMF'S UNION MACHINERY DIVISION USES THESE VICKERS COMPONENTS



CUSTOM POWER PACKAGE—A double-ended 60 hp electric drive motor is the prime mover for the two main hydraulic drives—one powering the developer (30 to 50 hp), the other driving the incorporator (5 to 10 hp). Vickers also supplies auxiliary control valving as part of the complete package. For more details on customized or standard power packages contact your Vickers application engineer.



PISTON PUMPS—AMF's application employs variable-displacement pumps having electrical remote volume control. Industry's broadest standard line includes models with flows to 180 gpm and pressures to 5000 psi, plus a wide variety of controls. For additional information write today for Bulletins 61-81, 61-84 and Catalog 5001C.

HYDRAULIC MOTORS—This fixed-displacement motor is only one of a complete line that includes models for variable horsepower (constant torque) or constant horsepower (variable torque) output characteristics in ratings from fractional to hundreds of hp.

Vickers adjustable-speed hydrostatic drives offer many unique advantages and economies—especially for applications where there are problems of space, weight, fast acceleration, infinite speed or tension control, sudden braking or reversing, hazardous or corrosive surroundings.

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Machinery Hydraulics Division

ADMINISTRATIVE and ENGINEERING CENTER

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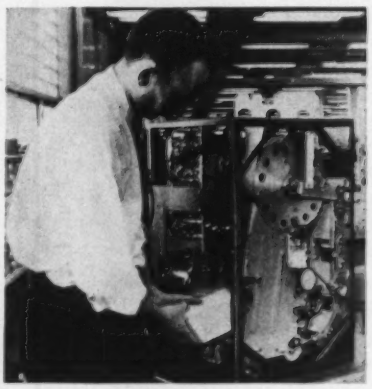
Corps program to produce reliable small systems for military use. They are expected to provide the first practical answer to the use of microminiature techniques in the development of advanced electronic devices such as desk-top computers, miniature communications systems, and equipment for space vehicles.

Metal Cleaning Scholarship Established

RESEARCH SCHOLARSHIP program for graduate study in metal cleaning operations and processes has been established jointly by Phillips Mfg. Co. and Diamond Alkali Co. The scholarship will be awarded on a yearly basis and will provide special funds and assistance for research study at the University of Pittsburgh. Plans are being made to strengthen the program with intensified research studies and special projects involving government and industry participation.

PROTECTIVE PACKAGING method developed by Westinghouse Electric Corp. holds switchboard instruments in suspension within formed plastic caps made of polyethylene. The plastic caps, designed



RECIRCULATING card reader offers features of punched tape control from cards. Designed by General Products Development Laboratory, International Business Machines Corp., the recirculating card programmer can treat any three cards in sequence as a single unit of instruction and is capable of rereading these cards without scanning through the entire deck. After the cards are read, they are immediately returned to a hopper in sequence and ready for feeding again. The new reader was developed to control testing programs on Nike-Hercules air-defense systems.

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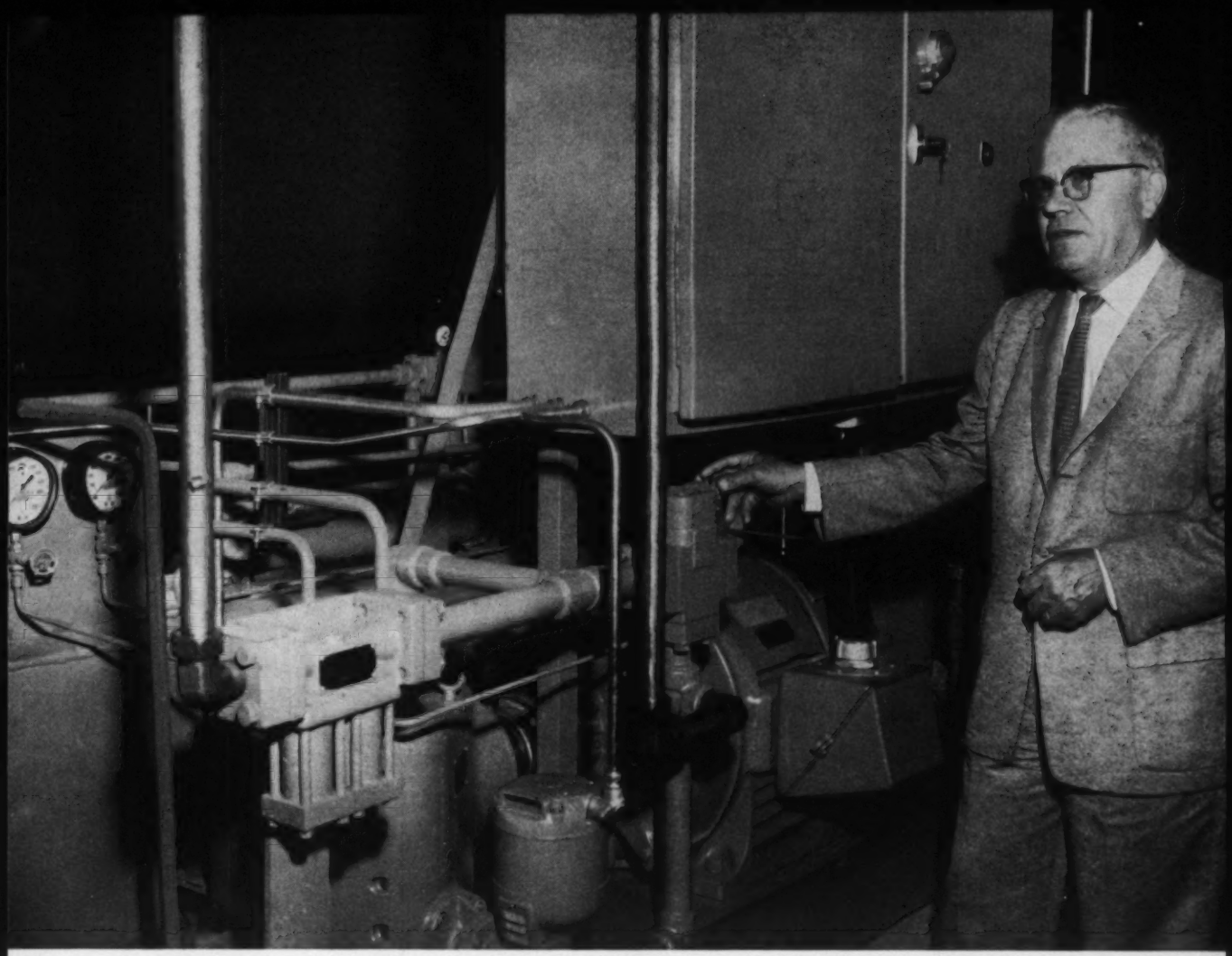

MELBURN B. HANCOCK, CHIEF ENGINEER, AMF'S UNION MACHINERY DIV., SAYS:

"Hydraulics give us compactness, easy clean-up..."

"... accurate speed control, and freedom from noise and vibration in the operating area. Because the use of adjustable speed hydrostatic transmissions on bread machinery was, in a sense, a pioneering effort, we found it essential and helpful to work closely with Vickers engineers in developing a completely workable system that offered our customers advantages unobtainable elsewhere.

"Our speed control must be accurate since any speed variation may degrade the end product. This speed control is required from about one-half speed to maximum speed of the equipment. Also, the system must be extremely flexible since operating speeds vary from time to time depending on characteristics of the raw material.

"With hydraulics we are able to reduce the overall size of the equipment for the production area where space is at a premium. Combined with other space saving design features, this machine is smaller than would otherwise be possible.

"Last ... but by no means least in the food industry ... is the ease with which the machine can be cleaned (firehoses are usually used to wash down equipment) because hydraulic units are sealed from external moisture, etc. This is a daily operation on breadmaking machinery and is a major advantage to commercial bakeries."

Whether your requirement is for a refinement to existing methods of applying hydraulics or a completely new approach to providing power and control to machinery, Vickers design and application engineers are ready to work with you to effect the most efficient and economical solution. See facing page for more details about components and systems used by Union Machinery Division, American Machine & Foundry Co., and the overall Vickers line.

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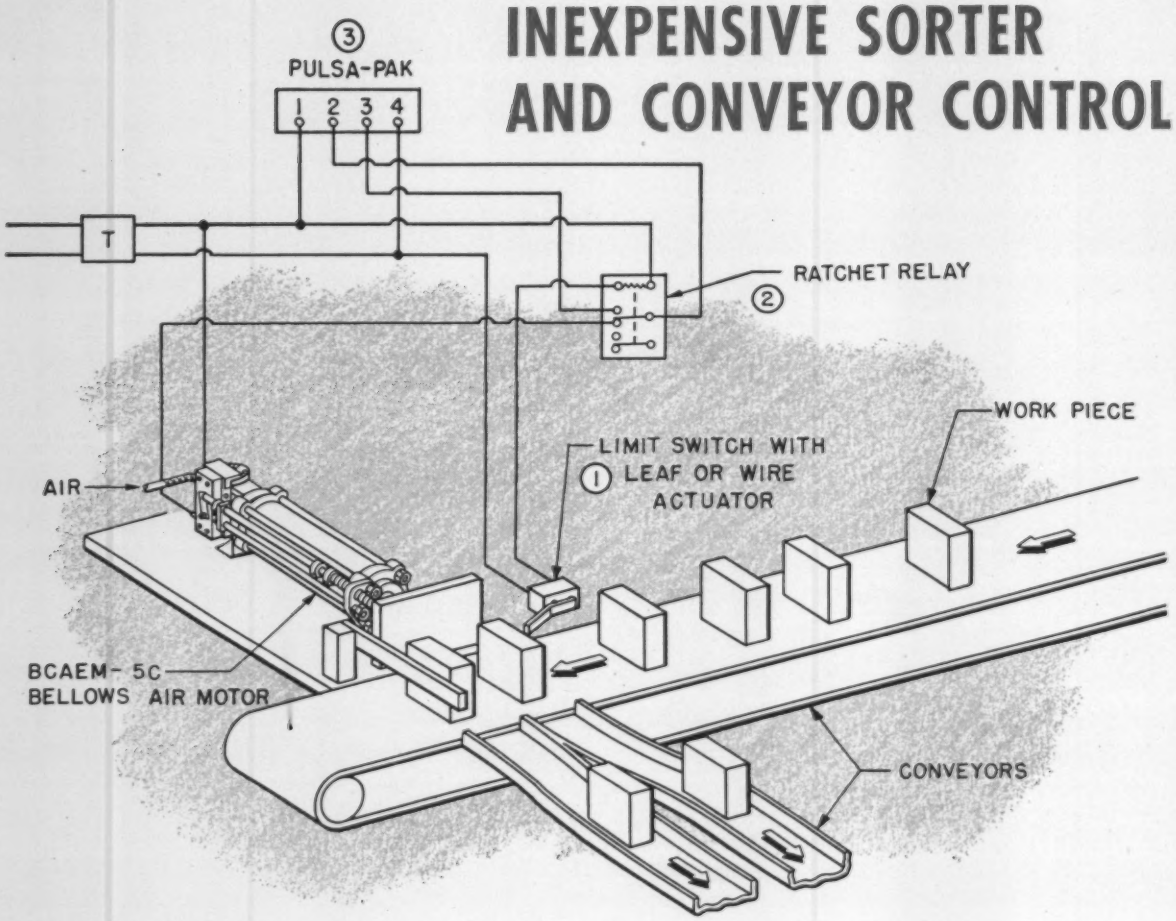
INEXPENSIVE SORTER AND CONVEYOR CONTROL



Here is a simple idea developed originally by a Bellows-Valvair user to feed back to two different points—but the basic idea can be readily adapted to many uses—for example, to feed parts to two separate assembly lines.

As the first part moves down the conveyor it trips limit switch (1) which causes the ratchet relay (2) to shift position and charge the capacitor in the Bellows Pulsa-Pak®. The first part moves on against the positive stop where it holds. The second part trips the limit switch (1) to shift the contacts of the ratchet relay (2) to the position shown, and to release a momentary electrical impulse from the Pulsa-Pak which causes the electrically-controlled, adjustable stroke Bellows Air Motor® to advance, feeding the two parts to the separate conveyors. The Air Motor automatically retracts and the cycle continues.

This is only typical of the many ways Bellows Air Motors are used to control the distribution of parts in conveyor operations. Distribution by size, shape or weight of parts to separate outlets is readily accomplished with Bellows Air Motors and their available controls. Your local Bellows-Valvair Field Engineer will be happy to work with you in applying these ingenious pneumatic devices to your operations.

THIS "SPOT-A-MATION IDEA" FILE IS YOURS ON REQUEST

Contains installation data, wiring diagrams, detailed descriptions of basic ideas you can adapt to your operations. Write for it today. Address Dept. AU-861 Bellows-Valvair, Akron 9, Ohio.

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AKRON 9, OHIO

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

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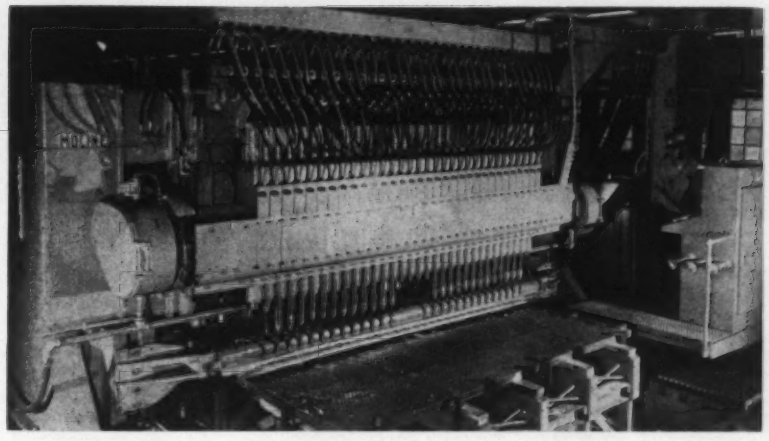

ELECTRONICALLY-CONTROLLED multispindle unit can drill more than 2000 holes per hour in 3/4-inch thick metal plates in an endless variety of patterns. Designed by Moline Tool Co. for Worthington Corp., the unit simultaneously operates 32 drill spindles to produce holes in condenser plates. Instead of moving the large metal plates into position under stationary spindles, this machine moves the drills into position over stationary plates. Commands from a punched tape control two-axis positioning of the machine.

to conform to the outer ends of the unit, are snapped on the ends to position the instrument in suspension within a carton. The method is so designed that it lends itself to mechanized packaging of high-volume items in an assembly line.

SPOTLIGHTING PEOPLE

Dr. J. Ernest Smith and **John R. Lenox** named vice presidents of the EDP Div., Minneapolis-Honeywell Regulator Co. . . . **Charles R. Larson** appointed chief engineer of Prab Conveyors Inc. . . . **Arnold C. Hansen** named general manager of the Thermostat Div. and **Arthur G. Baitz** appointed general manager of the Eastern Research Center and assistant vice president of Robertshaw-Fulton Controls Co. . . . **Harry A. Markle Jr.** named director of engineering, Fuller Co. . . . **E. W. Rawlings** appointed executive vice president, operations and finance at General Mills. . . . **Robert C. Palmer** elected president and a member of the board of directors of R. C. Mahon Co. . . . **Randolph L. Moulton** named manager, process automation engineering, Industry Control Dept., General Electric Co. . . . **Bruce A. Fleming** appointed executive vice president of the Edwin L. Wiegand Co. . . . **J. Roy Barefoot** named executive vice president, **Ralph N. Leitzell** appointed vice president and treasurer, **D. M. Davis** appointed vice president in charge of special projects, all at McKay Machine Co. . . . **Roy E. Lambert** named general manager, Indianapolis bearing plant of Link-Belt Co. . . . **Robert F. McCormick** of the Automatic Switch Co. elected president of the Fluid Controls Institute Inc. . . . **Jerrier A. Haddad** promoted to vice president and assistant general manager of the Data Systems Div., **Warren C. Hume** named president of the Data Processing Div. and **Gilbert E. Jones** appointed assistant to the president, all at International Business Machines Corp. . . . **Guy J. Coffey** elected chairman of the board and chief executive officer, **Norman Readman** president, and **Carra L. Lane** vice president and manager of plant operations at Chicago Pneumatic Tool Co. . . . **Clifford Amend** joined Ajax Magnethermic Corp. as metallurgist. . . . **James C. Crosby** promoted to manager of the DataTape engineering dept., Data Recorders Div., Consolidated Electrodynamics Corp. . . . **Walter Strand** elected president and **John Simms** vice president, both at Merkle-Korff Gear Co. . . . **Frank J. Durzo** named executive vice president of the Jeffrey Mfg. Co. . . . **Dr. T. Grant Maple** appointed senior physicist in the Research Div., Ampex Corp. . . . **William E. Shenk** named vice president of Abbey Etna Machine Co. . . . **Dale N. Woodford** appointed chief controls engineer, Sparton Electronics, Div.,

Don't give up

if your conveyor system is out of date or not saving money as it should. Modernize with Maitrol®. This versatile magnetic control system can rejuvenate the economics of your conveyor, large or small, and pay for itself at the same time.

- No wires between stations
- Destination or processing coding can ride with material even through interconveyor transfers
- Unlimited encoding combinations
- No rubbing or sliding parts to wear out
- Low cost, high reliability
- Simple pushbutton or dial control

Write today for Maitrol brochure. It gives full details.

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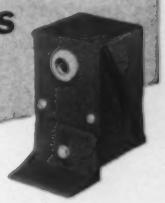
Transistorized Photoelectric Controls

small remote sensing and light source heads—two of the many items described in the complete catalog.



Built to heavy duty industrial standards. Conservative design provides wide margin of reliable operation.

Available with self-contained or remote sensing heads and light sources to meet widely varying requirements.

Complete catalog describes extensive line of transistorized and conventional photoelectric equipment—includes simplified diagrams of widely varied applications.

Send for your copy today.

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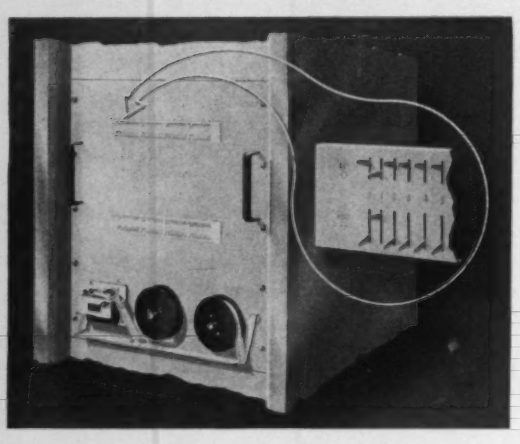
PRODUCTS

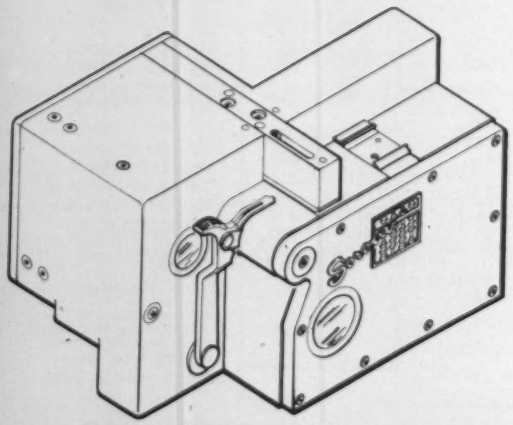


TAPE PROGRAMMED SWITCHING UNIT

This compact unit is comprised of a Model FR-310M Punched Tape Reader and a switching unit consisting of a mechanical decoding matrix and contact assembly. The package features 50 switching points — selected by the mechanical decoding matrix — each of which may be a latch or momentary type of operation. Any number of selected switch points may be latched before any are reset and each latching position may be set or reset by the same type code. Set or reset is controlled by simultaneous operation of a polarity solenoid and this solenoid may be controlled by one of the code channels of the punched tape. Adjacent switching points may be used for set and reset permitting different tape codes to be used for set and reset. Maximum operating speed is 15 codes/sec.

TAPE PREPARATION DEVICES

Soroban produces simple and reliable custom built tape preparation, reproduction and verification equipments. Units tailored to specific needs can be provided for operation with standard 5, 6, 7 and 8 hole narrow tape or 16 hole wide tapes. All make use of the flexible Soroban Automatic Coding Keyboard which can be supplied with almost any desired coding and keyboard key configuration.



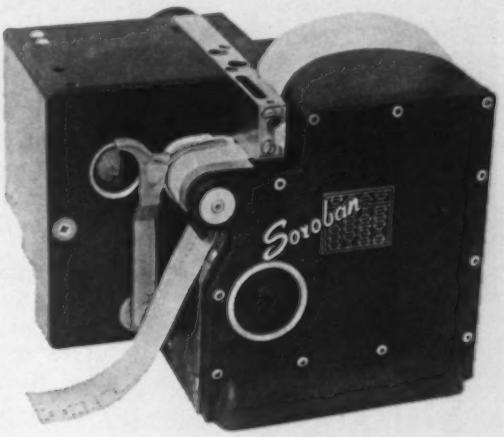
LP-2 LOW SPEED PERFORATOR

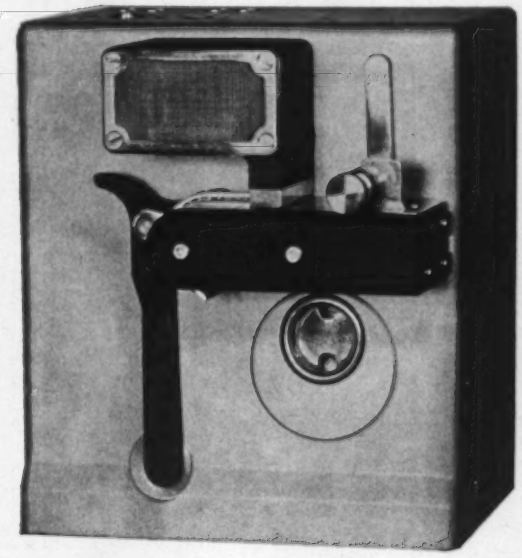
This Low Speed Tape Perforator was designed for rugged operation at punching speeds up to 120 codes/sec. It has many of the design features of the GP-2 Super-Speed Tape Perforator including feed mechanism, magnets, punch and die assemblies. In the LP-2 the tape passes horizontally over the punch head directly into the punch and die assembly. The straight line input was selected to permit introduction into the product line of an additional punch containing a high-speed print station adjacent to the punch and die assembly. The print station is capable of printing 64 different symbols at a rate of 100 characters/sec.

• RAPID
• RUGGED
• RELIABLE

GP-2 SUPER-SPEED TAPE PERFORATOR

A prime engineering achievement, the GP-2 Super-Speed Tape Perforator represents the most spectacular punched tape recording device to be released in recent years. The unit is capable of operating at speeds up to 300 codes per second — 3000 words per minute — or almost 10,000,000 holes per hour. This high speed perforator is currently being used by most of the national manufacturers of data processing and data handling equipment.



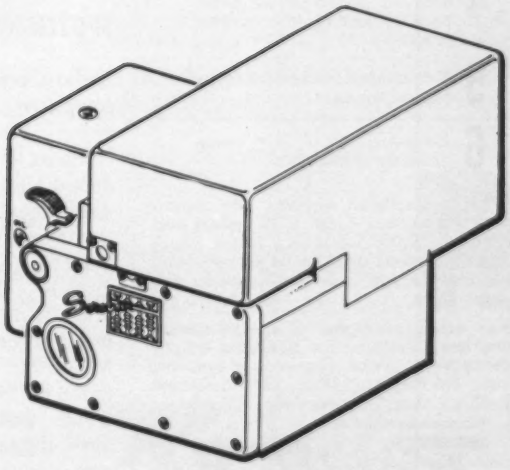


ANEMOMETER READER

A new Soroban development, the Anemometer (Hot Wire) Tape Reader was designed to offer rugged reliability in high speed tape reading as well as providing this same reliability at varying speeds from static to more than 500 inches per second. Integration of the anemometer sensing elements with the feed mechanism of the GP-2 Super Speed Tape Perforator into a single, compact unit will reliably read—character-by-character—speeds up to 300 codes per second. Gentle tape handling of even low grade paper tapes extends life to hundreds of passes.

PT-1 PERFORATOR & PRINTER

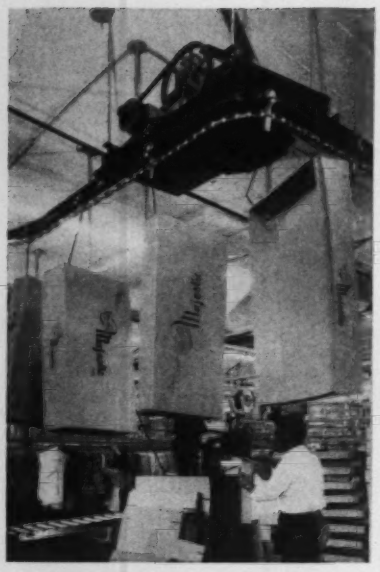
Consists of the LP-2 Low Speed Perforator (see text under same) and the MT-1 Printer. The latter was designed to print up to 64 different symbols at a rate of 100 impressions per second, 1000 words per minute . . . which is 10 times faster than the equipment previously available.



We welcome inquiry on any of the above or other Soroban products.

P. O. BOX 1717, MELBOURNE, FLORIDA, PA 3-7221

Circle 663 on Page 35



AERIAL CARTON STORAGE GIVES PROFITS A LIFT

Any manufacturing or warehouse operation that uses multiple packing stations or many kinds and sizes of cartons can profit from handling empty cartons on Rapistan overhead trolley conveyor. Present users are enjoying these benefits:

1. Automatic delivery of assembled cartons to point of use reduces handling labor.
2. Less floor space required for each packing station.
3. Mobile storage of made-up cartons off the floor.
4. Central stitching or stapling area for carton set-up close to knocked-down carton storage.
5. Removal of containers from unload areas.
6. Recirculation of tote boxes or other containers.

With a Rapistan system, one manufacturer gained a 10' x 15' office and space for 9,000 inventory items where empty cartons used to be stored—and reduced carton handling costs at the same time.

For other examples of money-saving overhead systems for handling empty containers, write Rapistan-Keystone, Inc., 556 Rapistan Bldg., Grand Rapids 2, Mich. Ask for report No. RK-13.

Rapistan®

OVERHEAD CONVEYORS

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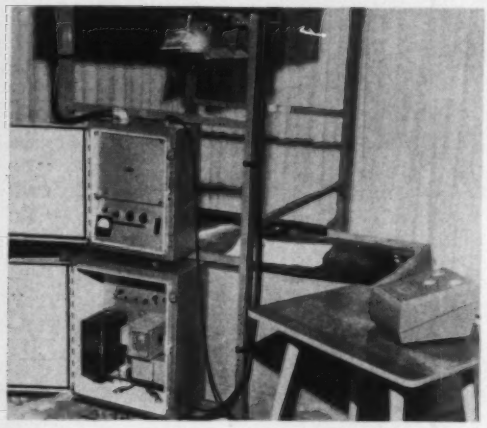


ELECTRONIC inspection machine was developed by the Linen Supply Association of America Research Fund to automatically inspect laundry flatwork for stains and tears. After bedsheets, towels, tablecloths, and other flatwork items are laundered and ironed, they pass through the automatic inspection device at a rate of 150 fpm. The flatwork is inspected by a light which is reflected off the linen surface to a photoelectric cell. Information from the cell is transmitted to the unit's electronic computer which measures the total area of holes and total area of stains, and classifies the linens into one of three categories: No damage or minimum damage; acceptable for certain uses, with some holes or stains; or unacceptable.

Sparton Corp. . . . **Dan L. McGurk** named associate general manager and **Louis B. Perillo** named director of marketing and manager of applications engineering, both at TRW Computers Co., Div., Thompson Ramo Wooldridge Inc. . . . **Otis J. Adams** appointed chief engineer of Bartlett-Snow, Div., Bartlett-Snow-Pacific. . . . **W. F. Wells** named senior vice president and general manager of Midwestern Instruments Inc. . . . **William R. Donnelly** appointed president of the Amplex Div., Chrysler Corp. . . . **Robert E. Learned** named production manager for diodes at Motorola Semiconductor Products Inc. . . . **John E. Polis** named manager of the Molecu-Dryer Div., C. I. Hayes Inc. . . . **James A. Witzler** promoted to general manager of Branson Corp. . . . **C. G. Blatchley** appointed chief engineer at Schutte and Koerting Co. . . .

SPOTLIGHTING PLANTS

Radio Corporation of America has completed a $4 million data processing center in Palm Beach Gardens, Fla. The center will produce EDP systems for business and government. . . . **Rolling Mills Inc.** is the name of a new company in Syracuse, N. Y. The company will produce cold roll forming machinery, flying cutoffs, and complete metal processing lines. . . . **General Mills** has formed an Electronics group to develop and produce electronic and electromechanical devices, digital computers, instruments and control systems, and precise gears and gear assemblies. The new Electronics Group includes Magnaflux Corp., Daven Co., and the former Mechanical Division. . . . **Fairbanks, Morse & Co.** has purchased the assets of the Herold Radio and Electronics Corp. in Yonkers, N. Y. Two operating divisions of Fairbanks, Morse—the Electronics Div. and the Scale Div.—and a number of general administrative functions of the company will be centered there. . . . **General Electric Co.** will expand their Rectifier Components Dept. in Auburn, N. Y. by 70,000 sq ft. Estimated cost of the program is in excess of $5 million. . . . **Giannini Controls Corp.** has added Cramer Controls Corp. to its firm as an operating division. The consolidation was based on the exchange of 83,000 shares of Giannini common stock for the assets and business of Cramer. . . . **Wallace Herdlein & Associates Inc.** is the name of a new firm that is specializing in designing, engineering, and manufacturing of metal cleaning, paint finishing, and air handling systems. They will also design plant layouts for such systems and ovens of all types, including low-temperature units for metal heat treating. . . . **Picker X-Ray Corp.** has formed a division to design and produce individualized non-destructive testing systems. The division will be called Picker Special Products and will be located in Cleveland. . . . **Industrial Timer Corp.** is constructing a 50,000 sq ft research and manufacturing plant near Parsippany, N. J. . . . **Brooks Instrument Co. Inc.** has acquired George K. Porter Inc. through a reorganization and exchange of stock. Porter will be operated as a wholly-owned subsidiary. . . . **Astrodata Inc.** is the name

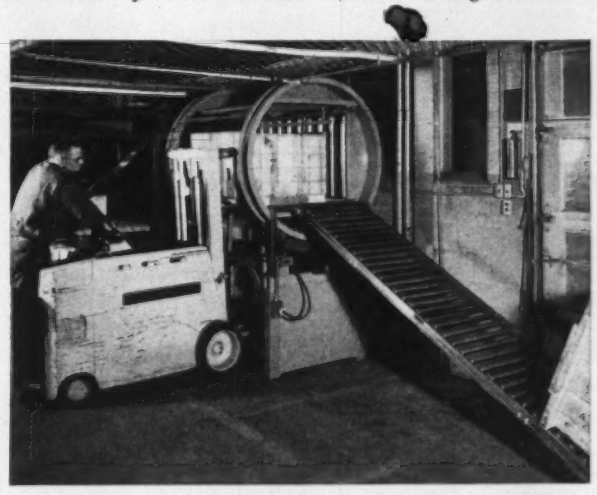
RAPISTAN Ideas HANDLING

HOW "TECHNICS" PLANNING PAYS "COMPOUND SAVINGS"

In any business, whether yours is a manufacturing plant, a wholesale warehouse, a retail or chain operation, or a service industry, materials handling is the one function that is closely related to all the other management arts.

Because of its influence on so many other departments and functions, it can be utilized as a management tool, to coordinate methods improvements throughout an organization, directed toward the common goal of reduced operating costs and increased profits.

This principle is the basis of Rapistan's proven "Technics" approach to cost reduction. It starts with the materials handling system, in all its aspects; then, extends the benefits of improved materials flow to produce subsidiary benefits in other areas of management as well.



New containerization of these conveyor wheels, specified by Purchasing, coupled with a new automatic unloading device designed by Plant Engineering, speeded truck unloading to 1/12th the former time. Wire-bound crates are designed for re-use as finished goods shipping containers for a further saving.

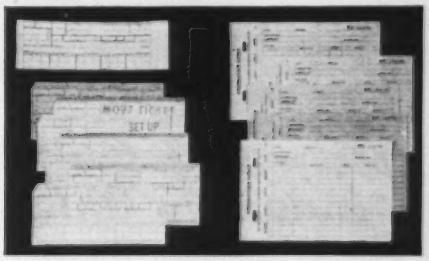
Thorough Planning—The Key

Rapistan's "Technics" concept of materials handling goes an important step beyond solving the problems of movement, transfer, storage and flow control. It recognizes the inter-relationships of the flow system with other management functions—purchasing, industrial engineering, product design, manufacturing, quality control—even clerical procedures.

By thorough planning, to augment and capitalize on improvements in the flow system through all related management activities, a "Technics" plan gives management maximum return on its investment.

A successful Technics program requires skillful coordination, under centralized and authoritative direction. Only top management can provide this. But, by the nature of his specialization, the materials handling engineer can contribute much to such a program. Your Rapistan sales engineer can offer new ideas and techniques of materials handling. And, his knowledge of "Technics" principles can help you compound the savings in many related phases of your total operation.

Plant engineers who designed this transfer mechanism to match Rapistan live storage Flow Racks helped make the entire system more efficient and versatile. Such contributions illustrate relationship between plant functions and materials handling, developed through Technics planning.



IBM data processing is coordinated with the flow system in this successful Technics program. These cards trigger movement of raw materials and work in process into and out of storage, and over the conveyor system between manufacturing operations.

The success of Rapistan's Technics approach to management of materials flow has been documented by over 70 pages of editorial comment in leading business and management publications. For your copy of this illustrated case study, write to The RAPIDS-STANDARD CO., Inc., 555 Rapistan Bldg., Grand Rapids 2, Michigan.

Rapistan®
CONVEYING EQUIPMENT

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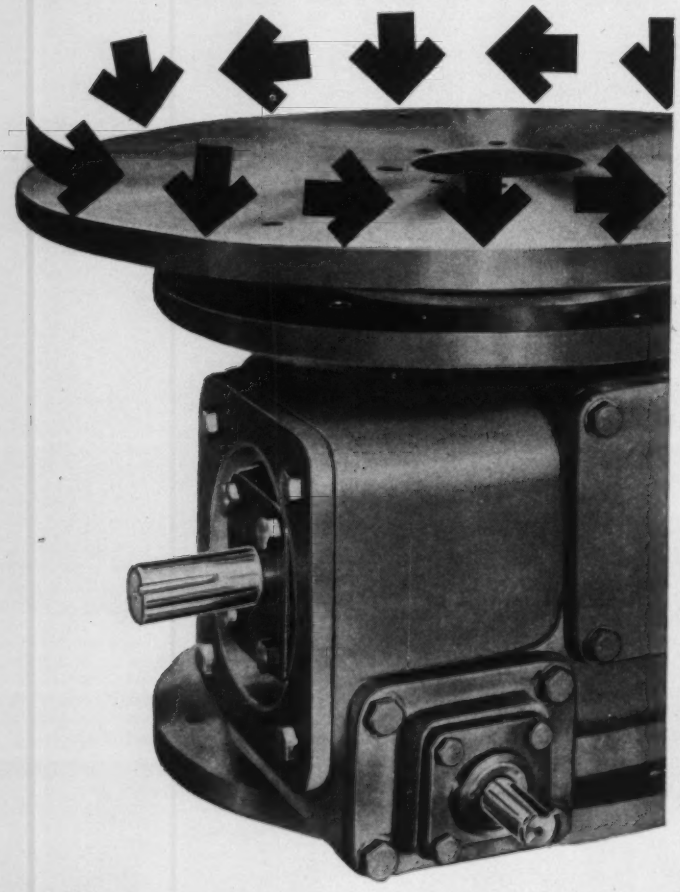
for vital cost reductions in assembly and machining



specify-**Standard Cam-Operated Indexing Units**/ Standard, Index Units . . . Rotary and Straight-line . . . are designed to be used in machines to provide automatic index motion to fixtured dials and direct mechanical motion to insertion stations, escapements and probes.

Fast, smooth, shock-free indexing is assured by the use of cycloidal cams—with extreme accuracy and at production rates to 6000 per hour.

Standard Model ST-A9AB Precision Rotary Index Unit. For light to medium duty. 4 to 20 stations. Accuracy to ±.0005″ at 6″ radius. Production rate to 6000 per hour.

Standard Model St.-A9B. Heavy duty Rotary. 8 to 24 stations. Accuracy to ±.001″ at 7″ radius. Production rates to 6000 per hour.

Standard Model St-A18 . . . Heavy duty transfer type, straight line unit 27 to 51 work carriers accuracy to ±.003″ production rates 6000 per hour.

Write for complete engineering bulletin, 26-A on Standard Cam-Operated Indexing Units.

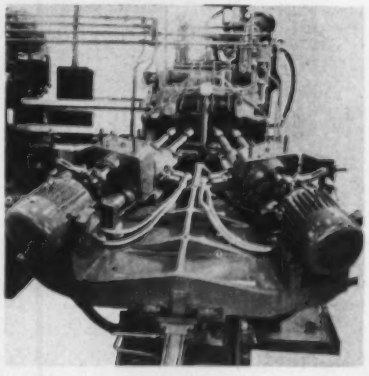
MACHINERY DIVISION

Standard Tool & Manufacturing Co.

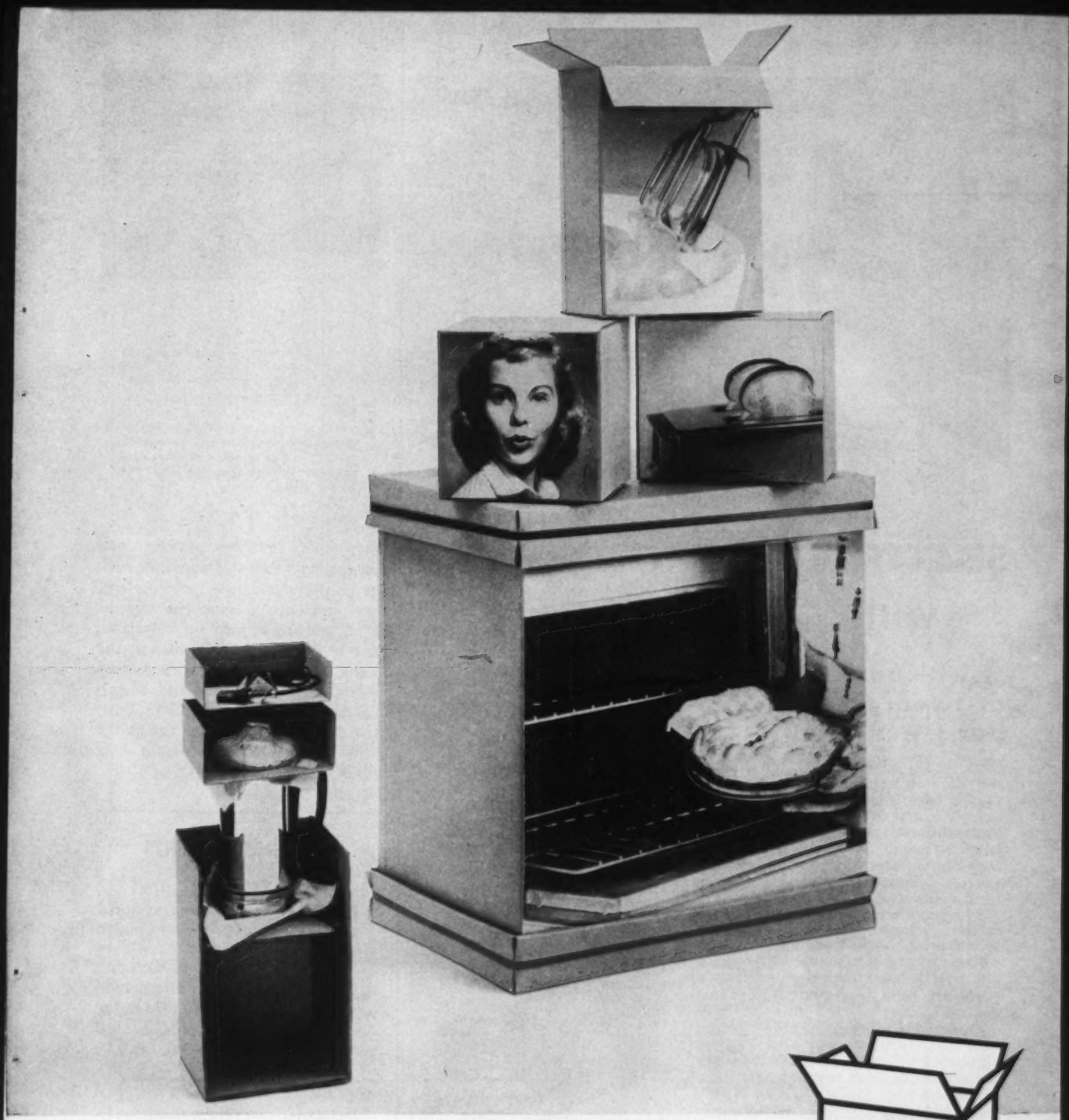
738 SCHUYLER AVENUE • LYNDHURST, NEW JERSEY

Better Products at Lower Cost Through Better Methods

of a new firm entering the data processing and timing equipment field. With the approval of the board of directors of Epsco Inc., the organization intends to acquire the assets of the Epsco/West Div. of Epsco as a nucleus for growth. . . . **Foxboro Co.** has acquired the assets of Waugh Engineering Co. in exchange for 12,806 shares of its common stock. The firm will be operated as a division of Foxboro. . . . **Ganlon Industries Inc.** is the name of a new organization which will specialize in the engineering and design of digital data handling systems, analog control systems, automatic checkout equipment, and transistorized circuit design. Facilities will be located in Long Island, N. Y. . . . **Dashew Business Machines Inc.** has acquired Automated Sensory Devices, manufacturers of punched card, paper tape, edge punch readers and other electronic data devices. It will be known as Electronic Datacoupler Inc. and will be operated as a wholly owned subsidiary of Dashew. . . . **Zero Mfg. Co.** has formed a new division to be known as Zero Research Laboratories. Function of the division will be to produce all types of metal joining, welding, and epoxy bonding. . . . **Trans-Plastics Corp.** is the name of a new organization which will design, develop, and fabricate

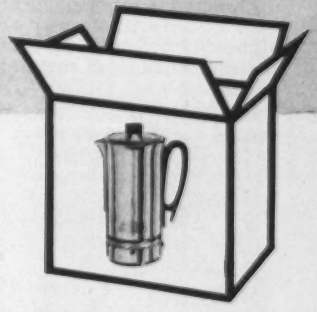


DUAL-HEAD way unit for tapping spark-plug holes in aluminum cylinder heads was developed by Foote-Burt Co. The spindles are at an included angle of 46 degrees and are angled 23 degrees downward. Hydraulic fast feed brings up the carriage bed on square ways. The independently driven lead screw tapping units then advance alternately to tap the work. At the correct depth, an electric brake stops the taps, the feed automatically reverses to back out the taps, and then the other head runs through its cycle.



Millions of kitchens in corrugated

America's fifty million homes use appliances by the kitchenful. Millions of toasters, coffee makers, ranges, washers and other wifesavers are shipped in boxes by Hinde & Dauch Division. Leading appliance manufacturers know they can count on H&D for money-saving *corrugated containers in volume.*



West Virginia Pulp and Paper

Hinde & Dauch Division

17 Plants • 42 Sales Offices • Sandusky, Ohio

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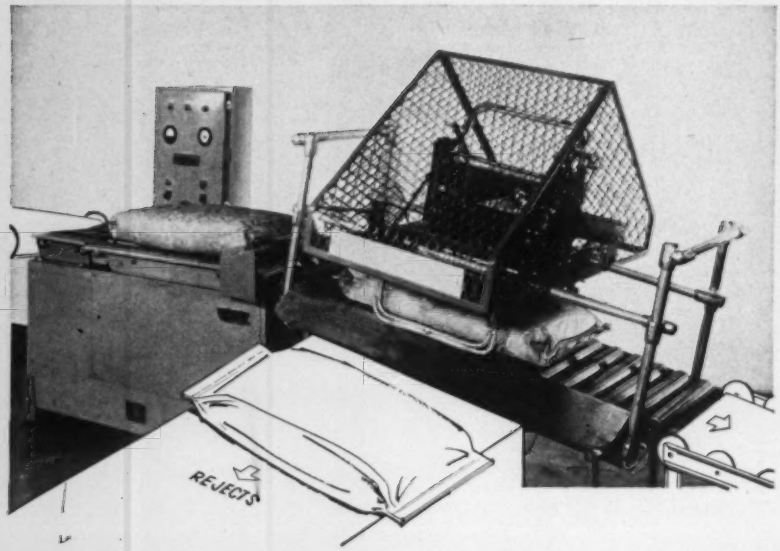


SELECTROL® checkweighs bags with 1/10 of 1% accuracy

...with rate of speed at twenty 50-pound bags per minute...

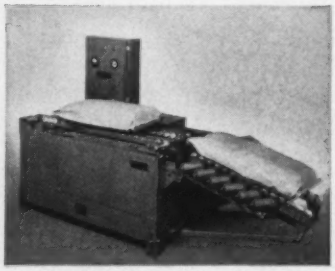
Model 1250 Selectrol, designed for installation in a production line, checkweighs bags from 25 to 150 pounds in motion... and detects weight variations as small as 1½ ounces or less per 100 pounds. Speed is variable — up to 25 bags per minute, depending on size and weight. Tolerance is adjustable to your requirements.

The Selectrol shown above has automatic overweight and underweight rejection mechanism. Models are available with underweight rejection only or without rejection mechanism. All electrical parts are fully protected against dust and oil.

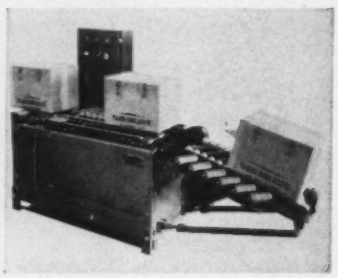
Optional equipment includes: recorders, counters, visual and audible signaling devices and special control accessories to your requirements.

Selectrols are made by Exact Weight, a leading manufacturer of job-engineered scales for 45 years with experience gained through hundreds of checkweighing installations.

WRITE FOR BULLETIN 3376



Selectrol Bag Checkweigher shown above without rejector mechanism



Selectrol Case and Carton Checkweigher with rejector mechanism. Acceptable weights continue in a straight line; over and under weight cartons are diverted off the line.

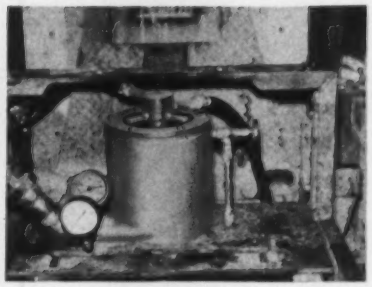
Exact Weight SCALES

THE EXACT WEIGHT SCALE CO.
907 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: 5 Six Points Road, Toronto 18, Ont.

Find us in your local 'Yellow Pages'

Sales and Service Coast to Coast

BETTER QUALITY CONTROL . . . BETTER COST CONTROL



CONTINUOUS casting of hollow billets and similar cored shapes in copper and copper-base alloys is now possible. Lobeck Casting Processes Inc. developed both the operating technique and built the casting installation, with the necessary water-cooled molds and mandrels. The billets produced have a sound internal structure and a high surface finish. The equipment can be applied to fully as well as semi-continuous casting machines employing the direct-chill casting method.

corrosion - resistant systems and components made of materials such as polyvinyl chloride, polyethylene, and acrylonitrile butadiene styrene. Facilities are located in Cleveland.

. . . **Bartlett-Snow-Pacific** is the name of a new corporation formed when Pacific Foundry and Metallurgy Co. purchased the C. O. Bartlett & Snow Co. Both companies will be operated as separate divisions of the corporation.

MEETINGS & EVENTS

July 31-Aug. 11—

Digital Control Systems Course. Two week summer course in digital control systems engineering will be held at Case Institute of Technology, Cleveland. More information available from Dr. Harry Mergler, Case Institute of Technology, University Circle, Cleveland 6, Ohio.

Aug. 6—

Industrial Research Conference. To be held Arden House, Harriman, N. Y. by Columbia University. Information available from Mary Garvey, Industrial and Management Engineering Dept., Columbia University, New York 27, N. Y.

Aug. 14-17—

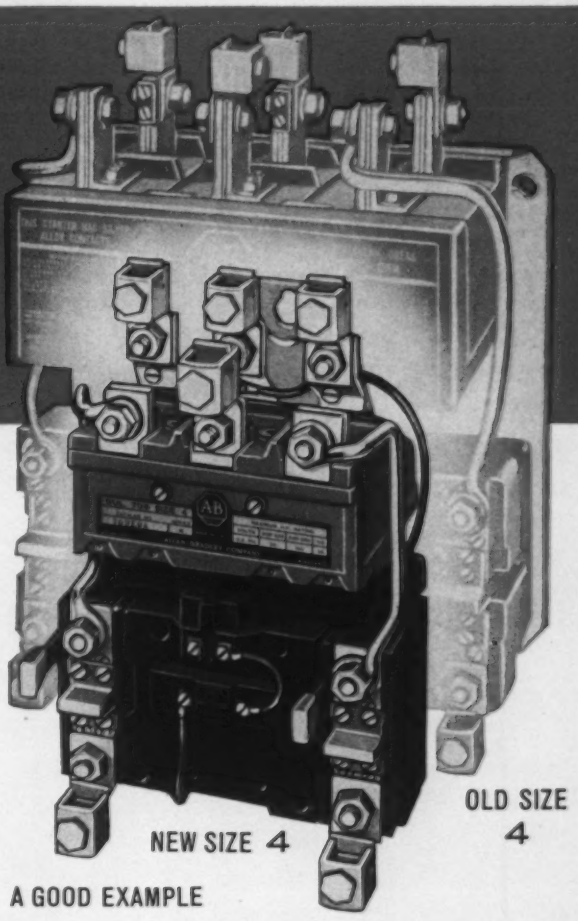
Society of Automotive Engineers. National West Coast meeting to be held Sheraton Hotel, Portland. Further details available from society

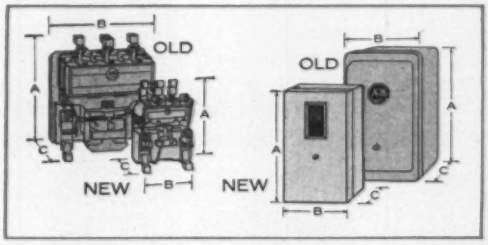
Circle 668 on Page 35

You get BIGGER PERFORMANCE

Plus SMALLER SIZE

with the new
Allen-Bradley
Bulletin 709 Starters





The new revolutionary Bulletin 709 motor starters are surprisingly small in size—yet, they are good for many more millions of operations—without trouble or maintenance! Rating for rating, they have no equal. They are today's best starter value—and they cost no more!

The "Quality" you've come to expect in all Allen-Bradley control is represented in all details—especially in the "eye appealing" enclosures styled by the world famous industrial designer, Brooks Stevens. Write today for details of the new Bulletin 709 line—the greatest advance in motor control in 30 years: *Allen-Bradley Co., 1339 South First Street, Milwaukee 4, Wisconsin.*

Check These New SPACE-SAVING Dimensions

Starter Size	OPEN TYPE STARTERS						NEMA 1 ENCLOSURES					
	Height A		Width B		Depth C		Height A		Width B		Depth C	
	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD
00	3⅝	—	3⅞	—	3⁹⁄₁₆	—	7⅝	—	4⅞	—	4¼	—
0	5⅞	5⅝	4¹⁄₁₆	4¾	3¹¹⁄₁₆	3¼	9⅛	7⅞	6⁹⁄₁₆	5⅝	4⅜	4¼
1	6⅝	5⅞	4½	5	3¹¹⁄₁₆	3¼	10	8¹³⁄₁₆	6¹³⁄₁₆	6⅜	4⅜	4¼
2	7⅝	10¹⁄₁₆	4⅝	5¾	3¹¹⁄₁₆	4⁷⁄₃₂	12	14½	7⅝	9	4⅜	5⁷⁄₁₆
3	10¼	12⅝	6¼	7¼	5⁷⁄₁₆	5⁷⁄₁₆	16⅝	19½	10⅜	11⅜	7	6¹¹⁄₁₆
4	11⁷⁄₁₆	16¼	7⁵⁄₁₆	12¾	6¼	6¹³⁄₁₆	22	26⁹⁄₁₆	11⅝	14³⁄₁₆	8	7¹¹⁄₁₆
5	14¹³⁄₁₆	20	9	16⅛	6½	8¾	32³⁄₁₆	41½	17³⁄₁₆	19⁹⁄₁₆	9⅞	13⁹⁄₁₆

ALLEN-BRADLEY
Member of NEMA

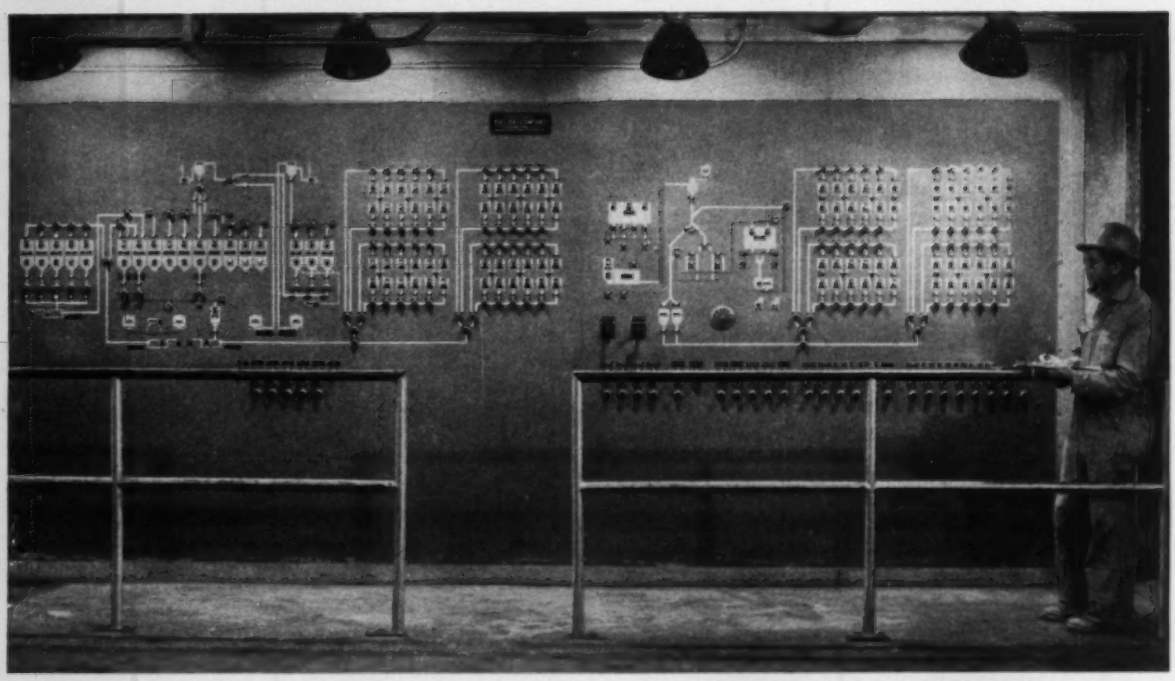
QUALITY MOTOR CONTROL

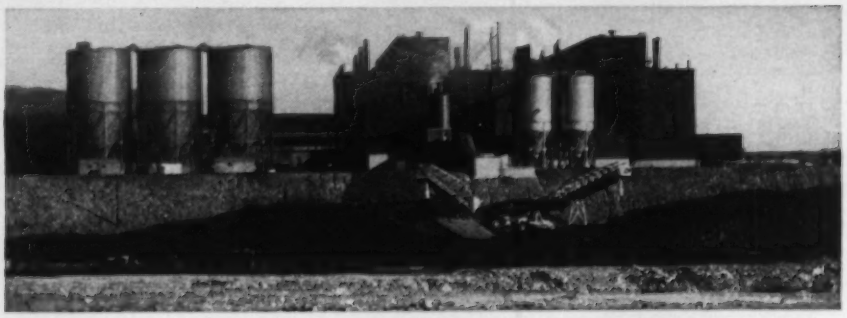
Circle 669 on Page 35

More "PAY-DIRT" With Fuller Panels In Control

One man on watch—and a Fuller Control Panel in control. Result: the flow of bulk, dry materials in a pneumatic conveying system graphically illustrated by diagrams and indication lights that track process transitions from phase to phase—without human errors!

Fuller Control Panels—automatic, remote, one-man control of multiple operations—stem from Fuller's vast materials handling and instrumentation experience. Fuller, the only manufacturer of pneumatic conveying equipment engaged in engineering and building its own control panels, puts its cumulative experience into each project. This single knowledgeable responsibility for both system and control means savings in time and costs. More important—it's your assurance that the total system is generic to your specific operational needs.





Look to Fuller's engineering-manufacturing team to develop the simplest possible control system without costly duplication or changes for you. Write for Bulletin G-9, today.

FULLER COMPANY GENERAL AMERICAN TRADE MARK

FULLER COMPANY
162 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

Fuller
....pioneers in harnessing AIR

2635
CP-2

Circle 670 on Page 35

headquarters, 485 Lexington Ave., New York 17, N. Y.

Aug. 14-18—

Gordon Research Conference on Instrumentation. To be held Colby Junior College, New London, N. H. Information available from W. George Parks, Colby Junior College, New London, N. H.

Aug. 15-18—

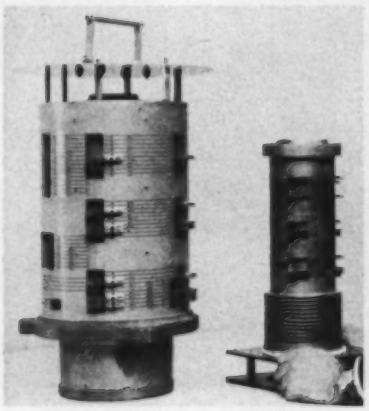
Technical Association of the Pulp and Paper Industry. Testing conference to be held Queen Elizabeth Hotel, Montreal, Que., Canada. Details available from association headquarters, 360 Lexington Ave., New York, N. Y.

Aug. 22-25—

Western Electronic Show and Convention. To be held Cow Palace, San Francisco. Information is available from WESCON, 1435 South La Cienega Blvd., Los Angeles, Calif.

Aug. 23-25—

American Institute of Electrical Engineers. Pacific general meeting to be held Hotel Utah, Salt Lake City, Utah. Information available



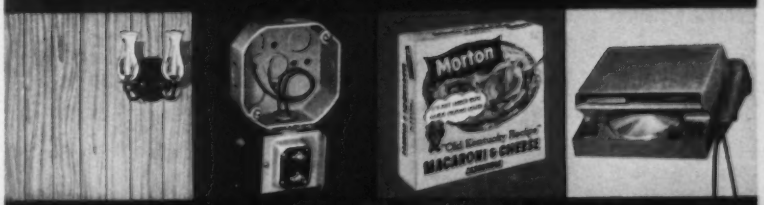
MEMORY DRUM made of stainless steel (right), can store 286,000 bits of information at less cost than its aluminum predecessor. This 4-inch drum is equal in storage capacity to an 8-inch aluminum drum (left) because the packing density in the stainless steel version was increased from 80 to 160 items per inch. Cost of the stainless steel drum is less than the aluminum one because expensive plating operations are unnecessary. Stainless steel also gives the drum greater reliability under a wide variety of environmental conditions, is corrosion resistant, and expands less than aluminum under heat. Unit was developed by Hughes Aircraft Co.

ELECTRIC INFRARED PROCESSING EQUIPMENT ALLOWS MANUFACTURERS TO COUNTDOWN TO A NEW MINIMUM TIME REQUIREMENT IN MANY INDUSTRIAL HEATING APPLICATIONS

The Fostoria Infrared process is partly responsible for the quality built into the products you see here. Its speed breaks bottlenecks in production techniques. Its flexibility allows adjustment to new conditions with a minimum of effort. Its versatility provides economies unheard of in convection heating equipment. If you use heat in your manufacturing process, make a note to check with Fostoria about how to improve product quality with this time-saving, money-saving, labor-saving electric infrared equipment.

For temperature requirements under 900° F. send for folder "Applications Unlimited."

For temperature requirements from 900° to 3000° F. send for "Breakthrough" folder.



COUNT DOWN

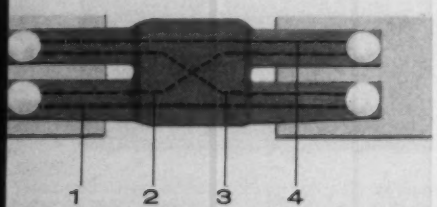
FOSTORIA

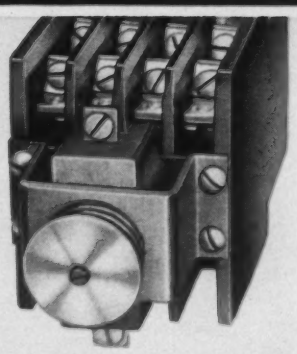
THE FOSTORIA CORPORATION • FOSTORIA, OHIO
MANUFACTURERS OF ENGINEERED RADIANT ENERGY EQUIPMENT AND CRITICAL WORK AREA LIGHTING

Circle 671 on Page 35

Another Cutler-Hammer first! Up to 24 poles in an area less than the size of a dollar bill.

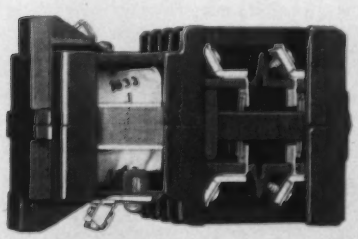
New contact reliability. Parallel bifurcated contacts, which allow four current paths instead of one, provide infinitely greater circuit reliability . . . liberally designed so any current path carries full relay rating.





At last! "Mechanical memory" latch as reliable as the relay itself! No adjustment ever needed. Add latch at any time.

New simplified design! Cutaway view shows basic simplicity. Coil vacuum impregnated to resist damage from humidity, vibration, electrical stress. Terminals can be screw or spade type.



Space savingest relay you've ever seen: New Cutler-Hammer "Compact 300"

Versatile 300 V. control relay is so reliable it's permanently sealed!

Here is the best answer yet to the need for an extremely reliable, small-size 300 V. industrial relay—the new Cutler-Hammer "Compact 300."

Every detail known that affects relay reliability has been improved in the "Compact 300." Bifurcated contacts which make possible *four* current paths rather than one, add millions of operations to the "Compact 300's" electrical reliability.

In fact, we're so confident of its electromechanical reliability, we permanently enclose the "Compact 300." And, if it should be damaged by a fault current, you throw it away and replace it with a new one. Its low price makes this an economical, practical maintenance procedure.

Now think of the space you can save with the "Compact 300." It controls up to eight circuits in panel space only 2" wide by 2¾" high. 2, 3, 4, 6 and 8 poles with any combination of N.O. or N.C. contacts are available, of course.

At any time, you can add "mechanical memory" latch with a life equal to the life of the relay. No adjustments are ever necessary. It's another exclusive! Better get full details on the new "Compact 300" now. Send for Pub. ED- L079-Q283.

What's new at Cutler-Hammer? New, better products, like the 300 V. relay are coming steadily from our new, expanded plant facilities. We're ready now to help you take care of the great industrial growth of the future. If you are planning ahead and need electrical control assistance, contact the nearest Cutler-Hammer sales office.

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

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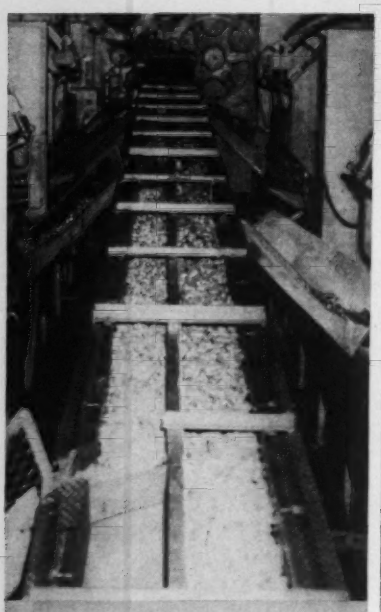
SANDVIK
STEEL BELT
CONVEYOR



Automates Heavy, Abrasive, Oily Load At Chrysler Corp.

At Chrysler Corporation's Mound Road engine plant this 24" x 120' Sandvik steel belt unit feeds or backlogs up to 2,400 rocker arms per hour in an automatic machining line.

Normal load is around 60 lbs. per foot but can run up to double that under back-up conditions. **The solid steel belt withstands this weight plus the oil and abrasion involved in carrying, live-backlogging and plowing-off the sharp-cornered rocker arms to each successive machine.**

Your nearest Sandvik office will be glad to furnish further information.

SANDVIK STEEL, INC.
Steel Belt Conveyor Dept.
1702 Nevins Road, Fair Lawn, N. J.

Cleveland, Detroit, Skokie, Ill., Los Angeles. In Canada: Sandvik Canadian Ltd., P.O. Drawer 1335, Sta. O, Montreal 9, P.Q.

SANDVIK STEEL BELT CONVEYORS

SS-238

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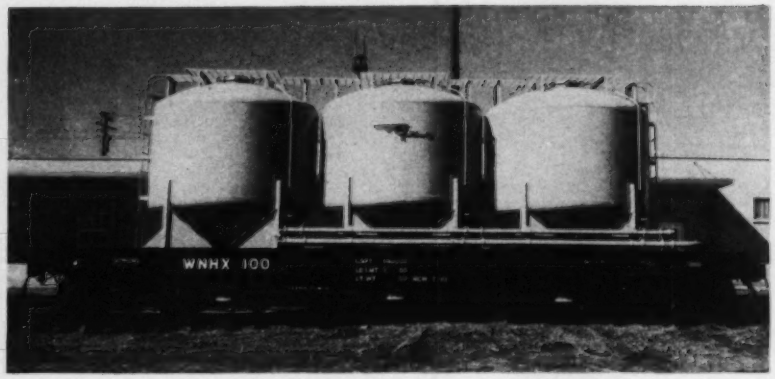


PNEUMATICALLY OPERATED tank railroad car is designed for hauling and transferring powdered, granular, and most pelletized dry materials. The car, engineered by Halliburton Co., mounts three tear drop tanks on a specially built railway car to provide capacity of 2400 cu ft and payload of 152,000 lb. The car can be unloaded anywhere a pipe or hose can be routed. The aeration system is designed so that as each load is moved, the tanks are self-cleaned.

from institute headquarters, 33 West 39th St., New York 18, N. Y.

Sept. 3-8—

American Chemical Society. National meeting to be held Chicago. More information available from society headquarters, 1155 Sixteenth St., N.W., Washington 6, D. C.

Sept. 6-8—

Joint Nuclear Instrumentation Symposium. Cosponsored by IRE, AIEE, and ISA. To be held North Carolina State College, Raleigh, N. C. Additional information from IRE headquarters, 1 East 79th St., New York 21, N. Y.

Sept. 6-8—

Institute of Radio Engineers. International symposium on transmission and processing of information to be held Massachusetts Institute of Technology. More information from institute headquarters, 1 East 79th St., New York 21, N. Y.

Sept. 6-8—

Association for Computing Machinery. Annual meeting to be held Statler Hilton Hotel, Los Angeles. Details available from Association for Computing Machinery, 14 East 69th St., New York 21, N. Y.

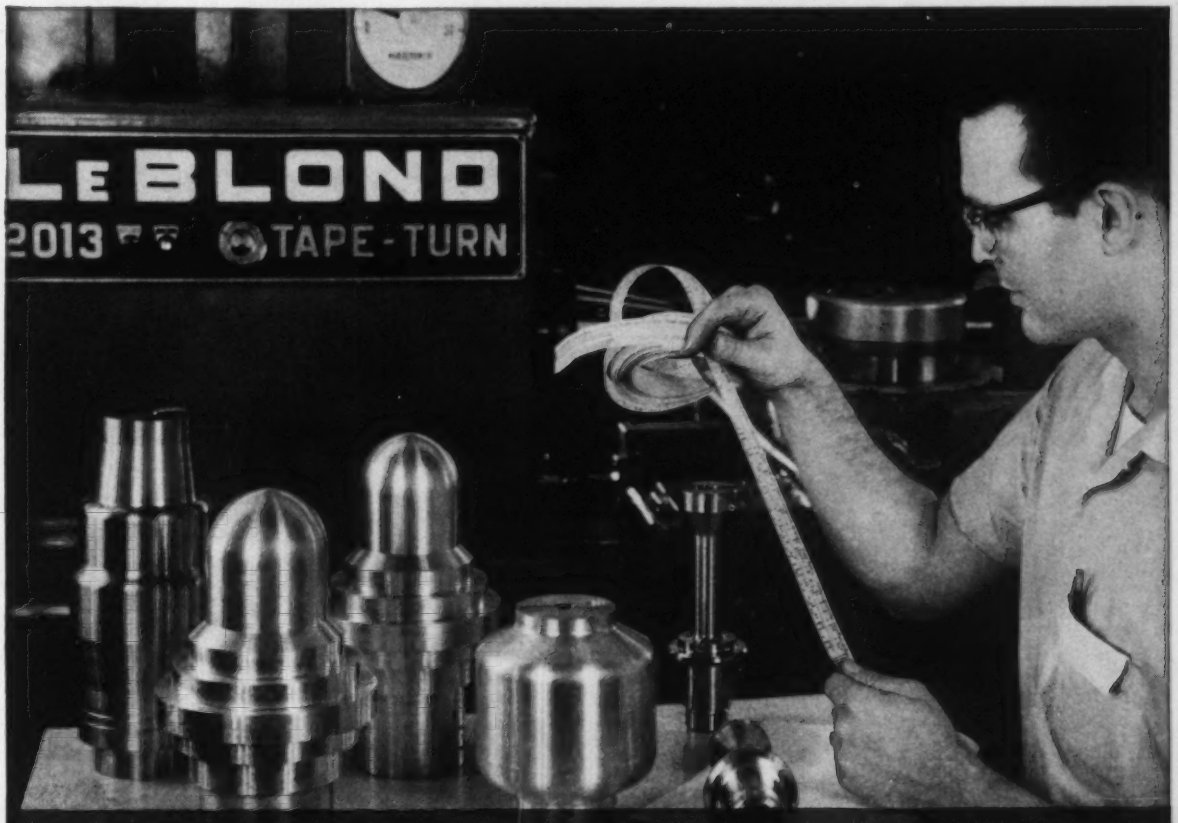
Sept. 11-14—

Society of Automotive Engineers. Convention and engineering display of farm, construction and industrial machinery; production; power plant; transportation and maintenance; and truck and bus activities will be known as Heavy Duty Vehicle Meeting to be held Milwaukee Auditorium, Milwaukee. Additional information available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

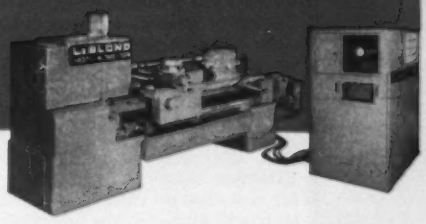
Sept. 11-15—

Instrument Society of America. Fall instrument-automation conference and exhibit to be held in Los Angeles. Conference will be in the Biltmore Hotel and the exhibit will be in the Memorial Sports Arena in Exposition Park. Additional information from society headquarters, Penn Sheraton Hotel, 530 William Penn Place, Pittsburgh 19, Pa.

"Fonsworth is a good engineer, but his military service influences his work."



Turn your parts profitably on LeBlond Tape-Turn



In production now, Eight Heavy-Duty Models:
2013, 2516 and 2516-20 NE, 20 hp. 2516, 3220 and 3220-25 NF, up to 50 hp. 4025 and 4025-32, up to 75 hp.

For turning complex contoured parts, in job lot quantities, Tape-Turn will show you rock-bottom costs! Its continuous path Mark Century tape control puts engineering data at the cutting edge far more efficiently than any manual or tracer turning method.

Because LeBlond pioneered continuous-path turning with tape, you'll benefit by many months of experience. We can show you actual applications on production runs. Our skilled programming staff will help your engineers learn the simple routines involved in tape turning.

Simple programming is a major feature of LeBlond Tape-Turn. The General Electric Mark Century control has a built-in computer which saves the programmer time in setting up for straight cuts, tapers, arcs and blended combinations of these. For the most complex shapes, separate computor assistance is desirable. You can learn the Tape-Turn programming procedure in half a day!

Increased efficiency, reduced lead time, a permanent record in easily stored form, low-cost quality control, reduced parts inventory, shorter set-up time and lower tooling costs—plus all the reliability and precision of a LeBlond Heavy-Duty Lathe—these are yours with LeBlond Tape-Turn. Write for descriptive bulletin TWF.

"Leading the way in numerically controlled turning"

LeBLOND of Cincinnati

The R. K. LeBlond Machine Tool Company
Cincinnati 8, Ohio

Circle 674 on Page 35

THE MOVE THAT COUNTS

AMP assures dependable programming performance with a patented double-wipe action which brightens contact surfaces . . . scrubs them clean of current-killing contaminants beyond the final contact operating point to provide a cleanly wiped contact area. This allows AMP systems to achieve .090" of wiping action with only .060" of pin travel after first contact with spring.

In addition to this "move that counts" AMP patchcord programming systems offer these features:

PATCHBOARDS

(Universal and Shielded types)

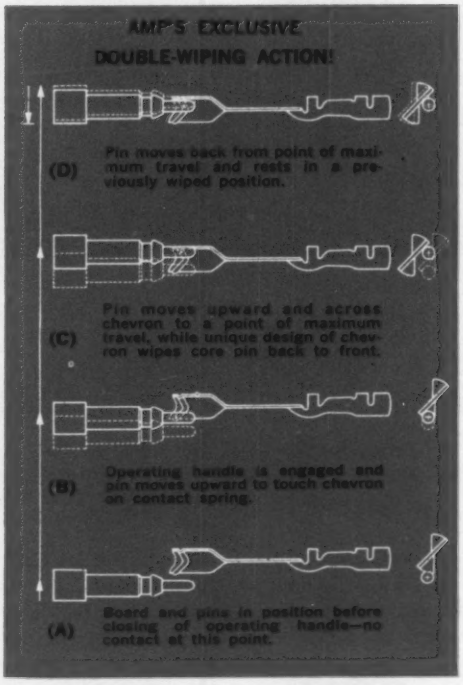
- Choice of general purpose boards in phenolic or diallyl-phthalate, and shielded types for critical low-level applications.
- Removable patchboard permits easy storage of predetermined wiring programs.

PATCHCORD PINS

- Pins compression-crimped onto conductor.
- Extended nylon sleeves act as insulation for pins, and provide proper seating of pins in board with positive detent action.

CONTACT SPRINGS

- Unique chevron design and 45° twist permit amplified contact pressure and wiping action . . . assure longer life.
- Contact springs are self-aligning and are locked in rear board.
- Provide receptacles for taper pins to facilitate equipment wiring.

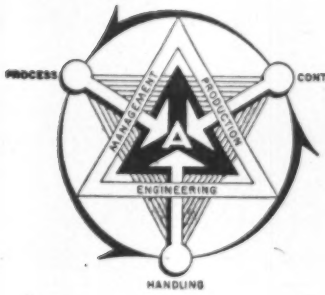

AMP'S EXCLUSIVE
DOUBLE-WIPING ACTION!
(D)
Pin moves back from point of maximum travel and rests in a previously wiped position.
(C)
Pin moves upward and across chevron to a point of maximum travel, while unique design of chevron wipes core pin back to front.
(B)
Operating handle is engaged and pin moves upward to touch chevron on contact spring.
(A)
Board and pins in position before closing of operating handle—no contact at this point.

AMP's NEW Patchboard Programming Catalog has all the information you need. Write for it today!

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany



around the triangle

SOLID FILM LUBRICANT ALSO CORROSION RESISTANT

An air dry solid film lubricant which combines corrosion resistance and lubrication in one step application has been developed by Electrofilm Inc. This new coating which eliminates the need for other coatings such as paint or electro-plate is 0.0002 to 0.0005 inch thick and has a coefficient of friction as low as 0.025 under high loads. It can be applied by spraying, dipping, or spray-tumble.

AIR FORCE WANTS STANDARDIZED CHECK-OUT SYSTEMS

Contract to study possible designs of automatic, standardized equipment for testing and checking out inertial guidance systems has been awarded to International Telephone & Telegraph Federal Laboratories by U. S. Air Force. This contract is part of the Air Force's new Project VATE (versatile automatic test equipment) which has as its objective the standardization and automation of USAF missile test equipment. Studies of automated test equipment are being conducted by ITT which will check out the guidance systems of the Atlas, Titan, Skybolt, Hound Dog, and Minuteman missiles. At the completion of these studies, all systems recommended for Project VATE will be evaluated by the Air Force.

NEW RECIPE FOR PUNCHING HOLES

Electrospark hole puncher, invented by a University of Michigan research engineer has been developed by *Better Homes & Gardens* magazine for use on the recipe pages of the foods section. The recipe pages are designed to fit in a ring-bound cook book. The hole in the paper is made by using a short burst of electric current. In operation, the paper web passes between a sintered aluminum oxide die and a narrow, 14 inch diameter wheel. The wheel barely touches the paper and turns with the web movement. Three needle-like electrode pairs pinpoint the release of a 20,000 v dc charge over a ¼ inch hole in the die. The Nylon wheel prevents too rapid dissipation of the energy when a spark hits the paper.

THIS PROCESS WORKS ON ALL METALS

Introduction of an electrochemical machining process that is applicable to all metals has been made by Hanson-Van Winkle-Munning Co. The process, developed by General Electric Co., is being made available to H-VW-M under GE license. This process involves stress-free machining of complex contours in a single operation. The workpiece and cutting tool (which is shaped like the desired part) serve as electrodes. In operation, a high amperage direct current is passed through the workpiece to the cutting tool, through an electrolyte, shaping the raw stock into the finished product. Close tolerances (±0.0005 inch) can be achieved and both minute and massive machining are possible.

ROLLING MILL OPERATION PROGRAM CONTROLLED

Reversing universal plate mill in operation at Republic Steel Corp. combines in-line process computer control with punched card programming. The mill control system incorporates a digital-type computer into a Prodac automatic control system designed by Westinghouse Electric Corp. The computer monitors roll pressure gage and x-ray thickness gage measurements to automatically predetermine mill settings before each pass. It also automatically controls slab elongation in a single pass roughing stand to control width of skelp furnished by broadside rolling in the reversing mill. When information from the punched cards is passed into the Prodac control system, it automatically directs the positioning of the roughing and main mill screwdowns, side guides, and edger adjustments.

AUTOMATION

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410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860
411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861
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420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870
421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871
422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872
423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873
424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874
425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875
426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876
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428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878
429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851
402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852
403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853
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406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856
407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857
408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858
409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859
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415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865
416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866
417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867
418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868
419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869
420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870
421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871
422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872
423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873
424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874
425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875
426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876
427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877
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430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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GAYLORD designs out the extras

Last year, a certain manufacturer used a shipping container with 21 interior pieces. Although it was effective, assembly costs were high, so the container was presented to Gaylord designers for revision.

Result: a container with only 9 interior pieces, that has less tare weight, makes assembly easier, and reduces packaging costs 33⅓%.

Simplify *your* packaging problems. Let Gaylord design the extra pieces, weight, trouble and cost *out* of your corrugated containers. Call your nearby Gaylord Man today.

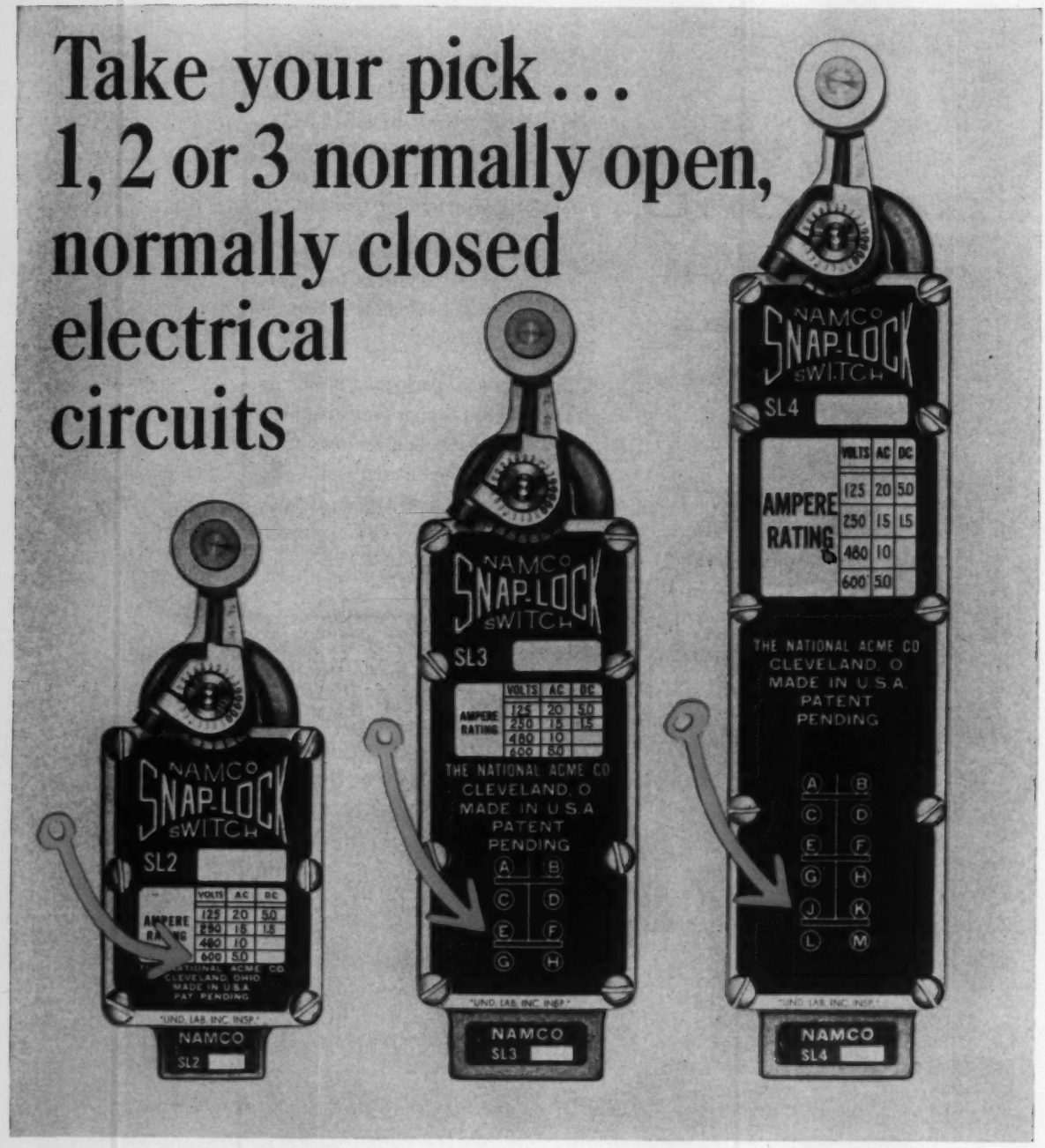
CROWN ZELLERBACH CORPORATION
GAYLORD CONTAINER DIVISION

IN CANADA · CROWN ZELLERBACH CANADA, LTD. VANCOUVER, B. C.

HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

Circle 676 on Page 35

Take your pick... 1, 2 or 3 normally open, normally closed electrical circuits



What does your limit switching application call for . . . one, two or three normally open, normally closed electrical circuits? Whatever it is, one of these National Acme SL "Machine Life" Limit Switches . . . the SL2, the SL3 or the SL4 . . . will meet your precise requirement. And, every SL offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (10½ lbs. at 1½" radius). Also available . . . the SLS 2, 3 or 4 featuring "hi-shock" sliding contacts; particularly suitable for drop forge, punch press and other heavy equipment application. Call, write or wire for complete information.

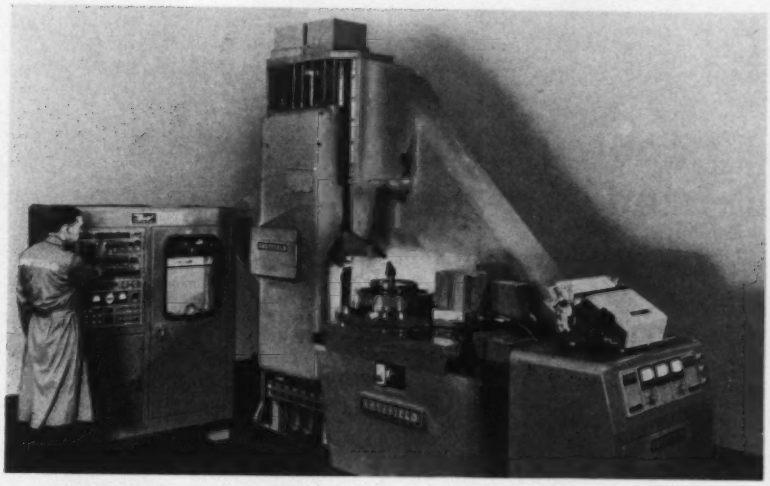
National Acme

THE NATIONAL ACME COMPANY
196 E. 131st STREET
CLEVELAND 8, OHIO

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

Circle 677 on Page 35

By LEE D. MILLER, Associate Editor



Universal 5-axis measuring machine built by Sheffield Corp. applies the flexibility of tape control to precision measurement. For demonstration purposes a clear plastic hemisphere is mounted in the position of the workpiece so that both the internal and external probes are visible. External contour, internal contour, and wall thickness are determined automatically and results printed out.

Too Much Starch

WHO put the starch in O'Hoolihan's long johns? The restrictive discomfort brought to mind by such a question has its comic aspects—provided that you aren't the wearer of the mistreated underwear. It seems that a little bit of inflexibility goes a long way in many areas. However, most of us can put up with a limited area of starched restriction when we have freedom to flex elsewhere in compensation.

Much the same effect can be observed in manufacturing operations. Very few manufacturing managers are blessed with demands which can be happily met without flexibility in manufacturing ingredients such as facility types and capacities, material flows, manpower, or operating rules and procedures. When the degree of starchiness increases significantly in one of these ingredients, increased flexibility in others will normally be required to prevent the development of a bad rash on the operating results.

Union-Made Starch

Manufacturing managements are currently being offered increased starchiness in manpower and operating factors under a union-made label. Illustrative of the trend are the July proposals of the United Auto Workers in Detroit. Among these proposals were suggestions for salaries for all workers, 65 per cent of working wage for every day of layoff, strict controls on overtime to spread available work, "contract protection" against subcontracting of work outside UAW jurisdiction, and sabbatical leaves for workers every few years without loss of income.

Regardless of the merit (or lack of same) involved in these suggestions, they clearly portray a union desire to eliminate flexibility in scheduling to meet fluctuations in demand. Leonard Woodcock, UAW representative at General Motors Corp., is reported to have commented with regard to the 65 per cent pay suggestion, "It would give management a strong incentive to schedule full-time work every week, because every hour not worked would represent a cost on management's books."

Compensating Flexibilities

It seems that no one has a good plan in effect to make market demands absolutely level or even to vary exactly in accord with forecasts. Even without union pressures for less flexibility in areas related to their members, adaptability in other areas has been desired to meet changes in market demands. With the union starching efforts, increased flexibility in other areas is especially desirable.

One of the areas in which gains in flexibility can be made involves the production equipment used. Stiffened production factors in other areas can be at least partially offset by increased versatility and adaptability of manufacturing equipment.

Increased equipment versatiity may take the form of provisions to allow faster setups on operations requiring frequent changeovers. As an example, Ford Motor Co. recently announced a substantial modernization program at its Cleveland Stamping Plant as part of a companywide program to achieve maximum flexibility of production facilities. Action at the stamping plant included installation of nine new presses. All but one of them are sliding bolster presses to permit more efficient die changes. These are the first sliding bolster presses to be used in this plant.

Versatility in Split Hairs

Flexibility of operation based on tape control has been a feature of many equipment developments. An interesting recent example of such equipment is a system for precision part measurement demonstrated by Sheffield Corp. They have built the first of a series of automatic measurement and printout systems for

Ex-Cell-O Model 922 Numera-Trol . . .

PRECISION IN MILLIONTHS PLUS COMPLETE VERSATILITY!

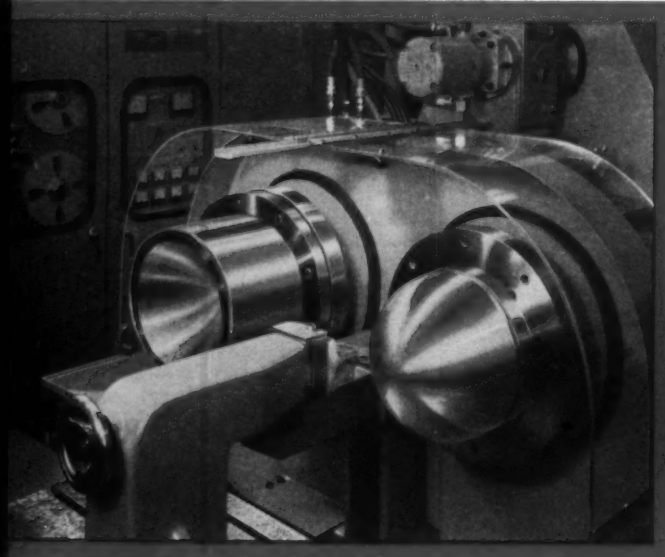
Interchangeable, self-contained units provide a universal, tape-controlled "production center" for . . .

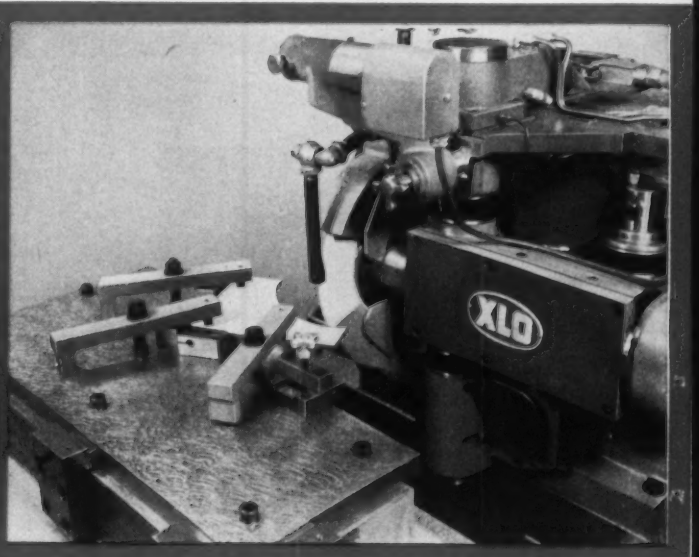
. . . Single and Double-spindle Boring and Turning
. . . Templet Grinding and Scribing
. . . Flat Circular Cam Grinding
. . . 3-Axis Vertical Contour Milling

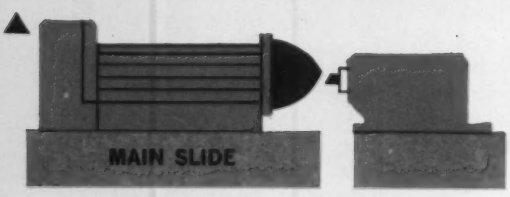
Ex-Cell-O's Model 922 Numera-Trol Machine gives you extremely broad design and manufacturing capabilities in a single production machine tool controllable to 25 millionths of an inch.

Interchangeable precision machining units mount on the main slide, and simply "plug in" to the machine's hydraulic, electrical and continuous-path numerical control circuits. In most cases, the Model 922 can be completely retooled and ready for entirely different, fully-automatic production in a few hours.

Send today for engineering and performance data, or call your Ex-Cell-O Representative for complete specifications.

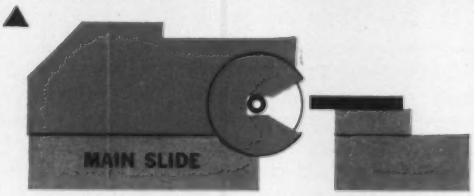






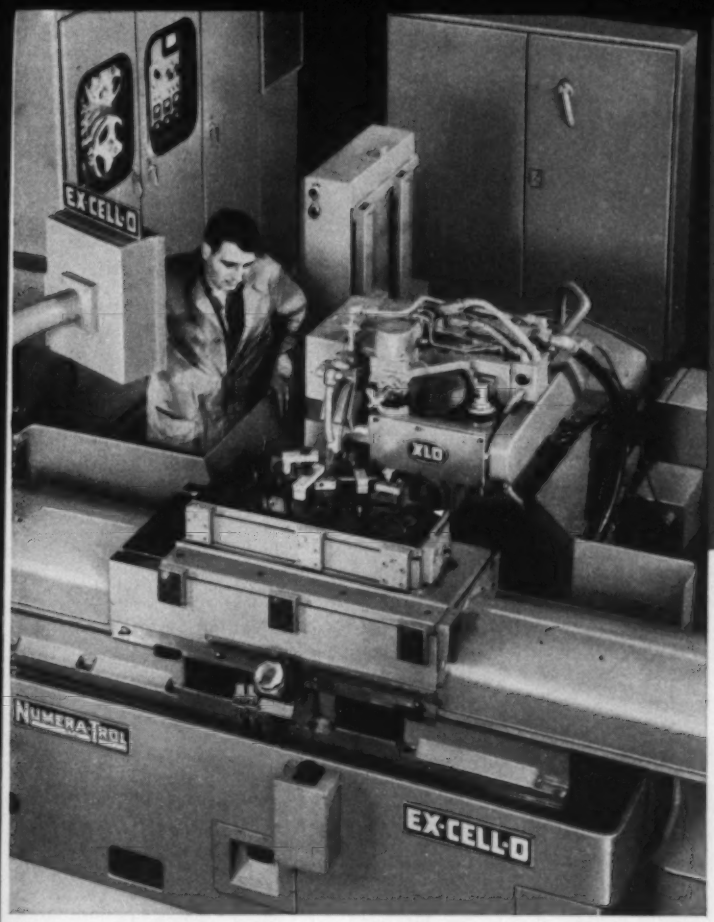
Single and Double-Spindle Turning-Boring Unit

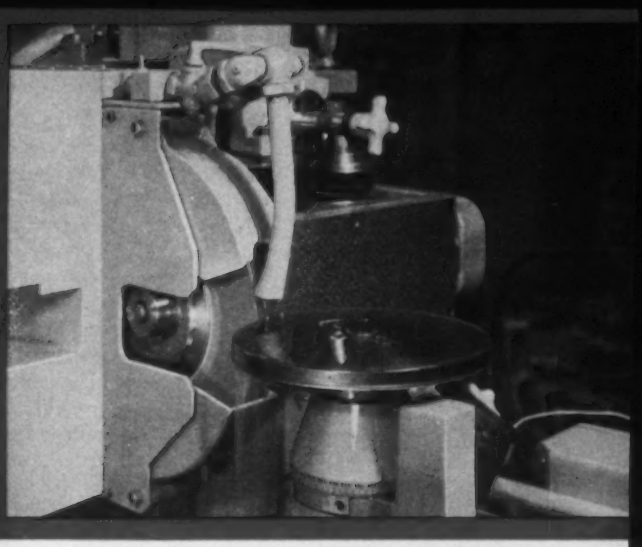
- Variable-speed workheads on main slide maintain constant surface speeds.
- Manual or automatic control of slides in .000025" increments.

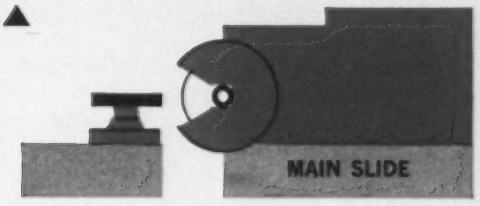


Templet Grinding-Scribing Unit

- Accommodates wheels up to 12" diameter on main slide.
- Manual or tape-controlled wheel dressing, size compensation and cycling.





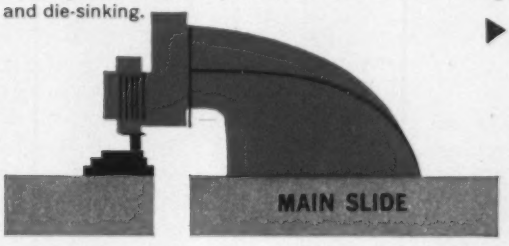


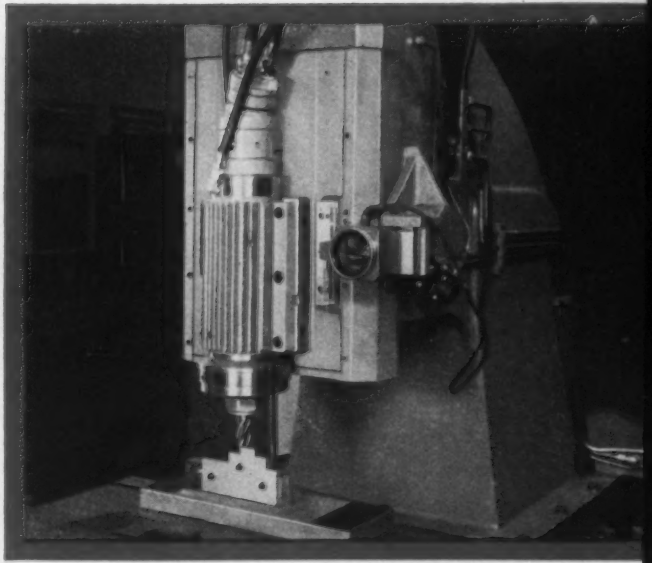
Flat Circular Cam Grinding Unit

- Adjustable, vertical-oscillating wheel spindle for flat-edge grinding.
- Tape-controlled rotary indexing fixture on cross-slide.

3-Axis Vertical Contour Milling Unit

- 6″ vertical column movement, 18″ main slide travel, 26″ cross-slide travel.
- Designed for extremely close-tolerance contour milling and die-sinking.





There's a Series 900 Numera-Trol to meet your most difficult jobs! Contact your Ex-Cell-O Representative, or write for literature on tape-controlled Ex-Cell-O Series 900 Numera-Trol Machines: Models 905 and 920 for both hemisphere and free-form boring and turning; Model 924 for grinding flat circular cams; the universal Model 922; and the Model 952 drum-cam and blade contouring machine.

61-22M

EX-CELL-O FOR PRECISION

PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILLING BUSHINGS • JIG AND FIXTURE COMPONENTS • TORQUE ACTUATORS • CONTOUR PROJECTORS GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

Machinery Division

EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

Circle 678 on Page 35

use in production of out-of-this-world vehicles and other fine-tolerance items.

Parts to be gaged can be up to 20 inches in height and diameter, and must have a minimum ID of two inches if internal measurement is required. Any point within this range can be gaged to an accuracy of 0.0001 inch with a repeatability closer than five millionths of an inch. The system automatically moves the workpiece, an external stylus, and an internal stylus to specified positions; senses deviations in the workpiece; and types out contour and thickness data.

Five axes of precision motion are provided. The workpiece is mounted on a table which can be rotated about a vertical axis, and this table can be moved linearly on a horizontal slide. Both horizontal and vertical positioning of the external stylus are provided, and the internal stlyus can be positioned vertically.

Quick-Change on Cranks

One solution to the problem of flexibility in a special purpose machining unit has been developed at R. K. LeBlond Machine Tool Co. They offer a crankshaft pin turning lathe with a packaged tool unit. The basic part of the machine provides chucks to hold each end of the workpiece. The two spindles on which the chucks are mounted are carried by a pivoted cradle. Motion of the cradle to feed the workpiece into the tools is provided by rotation of a cam geared to the spindle drive.

Tool holders, tool slides, and master crankshafts to suit a particular workpiece design are part of the tool unit package which forms the upper portion of the machine. This entire package is constructed for easy removal to facilitate changeover from one type of crankshaft to another.

Lee Boboltz of LeBlond discussed these crankshaft turning lathes at the 25th Annual Machine Tool Electrification Forum sponsored by Westinghouse Electric Corp. He pointed out that a manufacturer can purchase the machine with different packaged tool units as required. After running scheduled production of one type of crankshaft, the user can install another package unit in two to eight hours and then be back in production on a different type of crankshaft. With other designs of crankshaft lathes the entire machine is often returned to the factory for rebuilding to achieve such a changeover. In the packaged tool unit concept, the machine stays in production but the displaced tool unit can be returned to the factory for rebuilding.

Cat-Like Agility

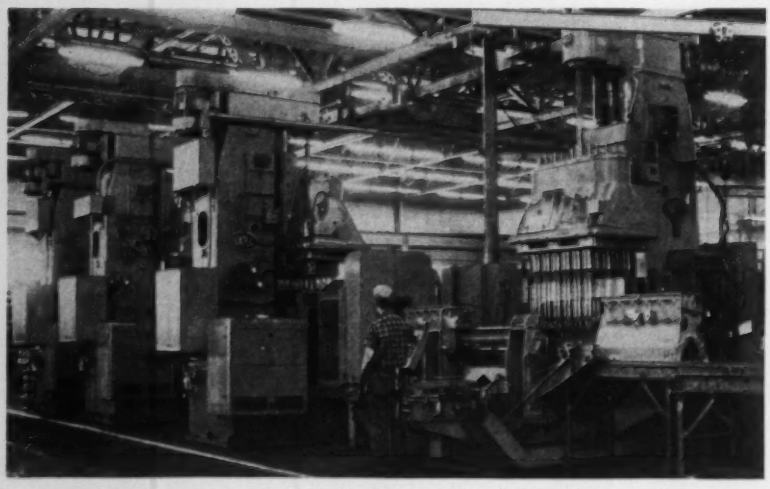
At Caterpillar Tractor Co. a "transfer machine" was installed that has flexibility in function of the entire line. The Caterpillar line to machine 4 and 6-cylinder diesel engine blocks includes some 30 separate machines tied together with transfer equipment.

Four of the machines in the line were built as conventional units by National Automatic Tool Co., and tied together in what Natco calls a "convertible transfer line." The machines are three two-way units with horizontal and vertical drilling heads, and one vertical unit.

Each machine is a self-contained unit on its own base, with its own hydraulic pump, coolant, and electrical equipment. Each unit is tooled with its own loading, location, clamping, and unloading fixtures but is linked to other units in the line by automatic transfer mechanisms.

The electrical controls for each unit are built for independent automatic cycling, but require only a simple electrical interlock to control the battery of machines as a unit from a master control panel. Since each machine is self-contained and has its own control panel, any of the four machines can be removed from the group and operated independently. It can be replaced in the line by a simple conveyor link or another machine.

Linking the four machines together cost only about 12½ per cent more than the machines separately, and much of this additional cost was for transfer equipment. With the provisions incorporated in the individual machines for changeover flexibility, plus the adaptability of the group, the convertible transfer line seems an attractive approach.



Convertible transfer line at Caterpillar Tractor Co. is formed from four conventional multiple spindle drilling machines built by National Automatic Tool Co. The machines can be operated singly or as a four-machine unit to offer versatility in a medium volume production line.

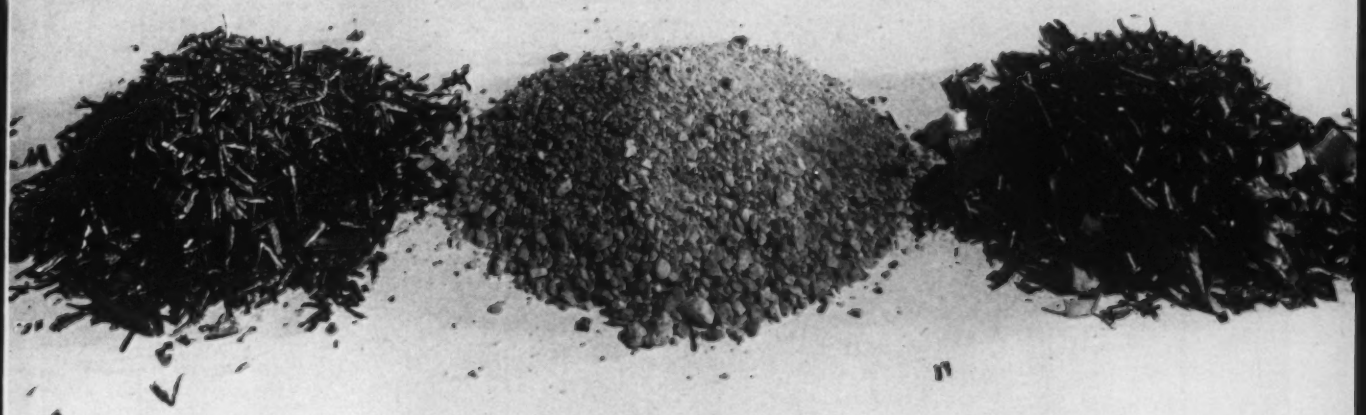
De-Starching Unlimited

These examples of increased flexibility in automated equipment indicate some of the possibilities to compensate for increased rigidity in other operating factors. Fortunately, the possibilities cover the whole spectrum from 1-piece lots to the millions-per-order category. The project involved may range from daily changeover of a single machine to yearly re-alignment of a multimachine line. Progress in this direction is limited only if users and builders fail to co-operate imaginatively.

Circle 679 on Page 35→

the precision air valve

with the stainless steel stomach!



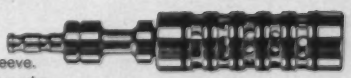
Air lines get dirty even in the best of plants. Dirt stops most valves, and production. But a Numatics valve keeps on working.

We don't say it's impossible to jam a Numatics valve but you can't hurt it with dirt. Why? The hardened, stainless steel, lapped spool and sleeve—unique in the industry. No resilient seals to get chewed up, or seize after long shut-downs. Working smoothly with millionths of an inch clearance, the stainless sleeve and spool—with razor sharp lands—will digest a diet of cast iron, aluminum, and steel chips, and foundry sand.

A Numatics valve will keep on working (even improve with service) under conditions that would stop an ordinary packed valve dead.

Any wonder we call Numatics valves the most reliable in the industry?

Buy Numatics—and relax.



The lapped spool and sleeve.
It works, and works, and works.

NUMATICS, Inc.

Highland, Michigan

new–lube-free...

STERLING
Sealed and shielded bearings require no lubrication.
Keys are fabricated from tough elastic material to eliminate key and keyway wear.
Wear-resistant non-metallic bushings require no lubrication.
Shaft surfaces are corrosion-proof and require no lubrication.
CAUTION

...Sterling's variable speed drive never requires lubrication

Costs Reduced—One of management's biggest headaches has been the development and maintenance of proper lubrication schedules. As a consequence, lubrication problems have long been the cause of variable speed drive failures, pulley wear, sticky pulleys, shortened belt life, excessive noise, and many other equally costly problems.

High labor costs, coupled with increased maintenance needs, are major management problems.

Lubrication Eliminated—Now, Sterling has eliminated all lubrication maintenance problems. No part of a Sterling variable speed drive needs to be lubricated.

All bearings, sealed and shielded, are factory-lubricated and therefore require no lubrication. Shaft surfaces are impregnated with a special exceptionally tough and wear-resistant material which eliminates need for lubrication. The non-metallic bushings are also fabricated from a special material that is equally wear-resistant.

Special Load-Bearing Surfaces—At no time do these surfaces require any attention. Even the keys are fabricated from a tough elastic material and will not wear out.

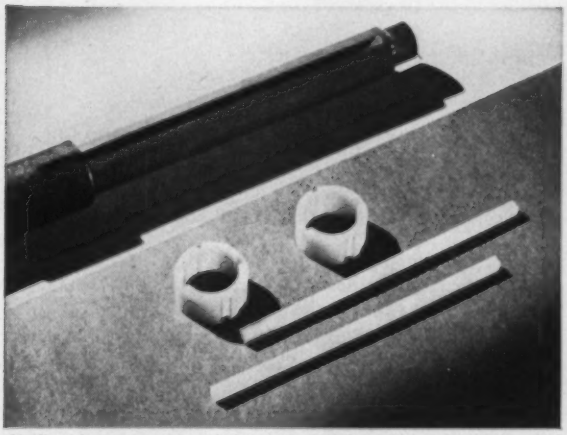
Fret corrosion, long a problem with metallic load-bearing surfaces, is completely eliminated since non-metallic surfaces now carry the load. Sticky pulleys, frequently the result of improper lubrication, are no longer a problem.

Sterling's new "Lube-Free" variable speed drive can be installed in any location, no matter how inaccessible, since lubrication maintenance is no longer needed.

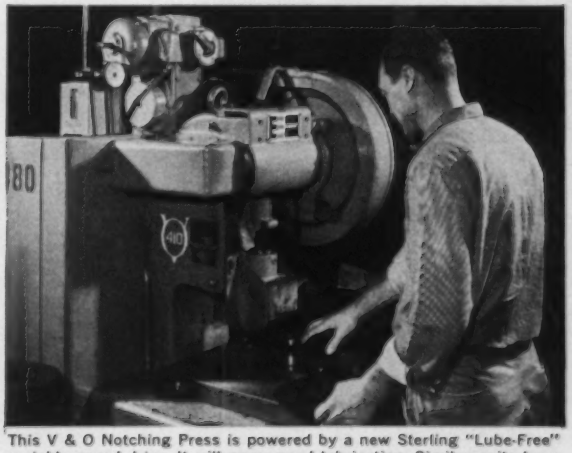
Other Benefits—Costs are reduced, money saved, when lubrication maintenance is no longer necessary. Belt life is lengthened; pulley wear is eliminated. Bearing life may also be lengthened by the elimination of worn pulleys—often the cause of vibration and bearing wear.

All other Sterling variable speed advantages are present in this new "Lube-Free" drive: wide range of speeds, heavy duty cast iron case, finger-tip speed control, etc.

Information Available—Complete application and product information is available by writing Dept. B-8, Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, California—or by contacting the Sterling field engineer in your area.



Shaft surfaces are extremely tough; material provides unusual chemical resistance and anti-frictional properties that make an excellent load-bearing material operating under extremely low or high temperatures. Keys and bushings are fabricated from a material proven to have outstanding abrasion resistance; holds up indefinitely under frictional conditions, thus eliminating need for lubrication.



This V & O Notching Press is powered by a new Sterling "Lube-Free" variable speed drive. It will never need lubrication. Similar units have been installed in the food processing industry. The elimination of lubrication is particularly important in the food processing industry where variable speed drives have such wide application, and where oil and grease create sanitation problems.

Hathaway INSTRUMENTS INC.

Sterling Electric Motors, Inc.

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Circle 680 on Page 35

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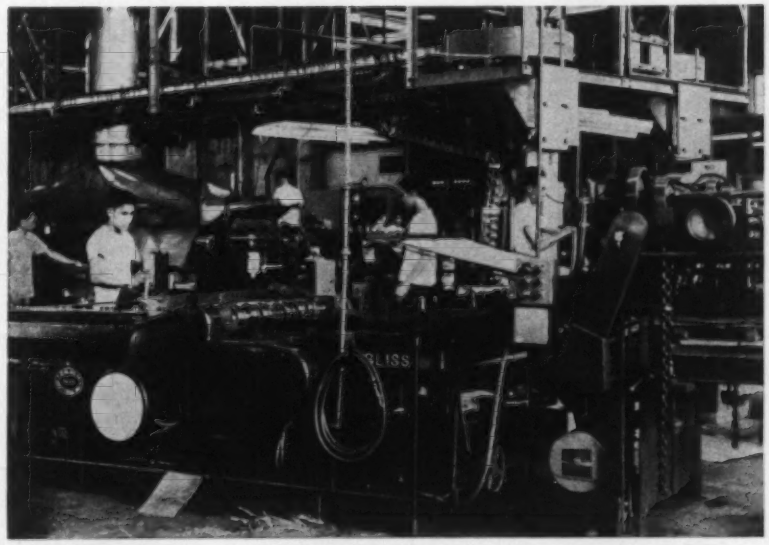


Paranaque, Philippines—Recognizing the economic advantages of large-scale, domestic manufacture of containers for canned milk products, a Philippine realty company, Standard Investment Corp., has set up this can making plant near the Darigold Milk Co. plant on Rizal Island. Facility will supply the full requirements of the milk company for 300 x 400 open-top, 14-oz. milk cans. Present output of the can line, supplied by E. W. Bliss Co., is 2.1 million cans per week.

Highly Instrumented

IN THE NETHERLANDS, at the Sluiskil plant of Compagnie Neerlandaise de L'Azote, a fuel oil pressure gasification plant recently went on stream to produce sufficient hydrogen for the manufacture of 100 metric tons of synthetic ammonia per day. The plant, designed and engineered by Montecatini Co., makes extensive use of process instruments and automatic controls.

A feature of the process is the gasification of liquid fuel oil ("bunker 6" type) at the relatively high pressure of about 210 psi in the presence of preheated oxygen. Carbon black is removed from the product by means of a cyclone separator system.

Washing to remove hydrogen sulphide and carbon dioxide from the gaseous stream is accomplished with ammonia liquor. The washing liquor is regenerated by means of recovered heat, and the gaseous mixture is fed to a conversion plant. In the latter unit, carbon monoxide is converted to carbon dioxide over a catalyst in the presence of steam.

According to Dr. Ing. Giorgio Abbate Daga, all of the foregoing processes used by its Dutch associate were developed by Montecatini, and have resulted in substantial savings in the raw materials and electric power normally required for this type of production. In addition, a considerable amount of heat is recovered from the gasification process and used to produce steam.

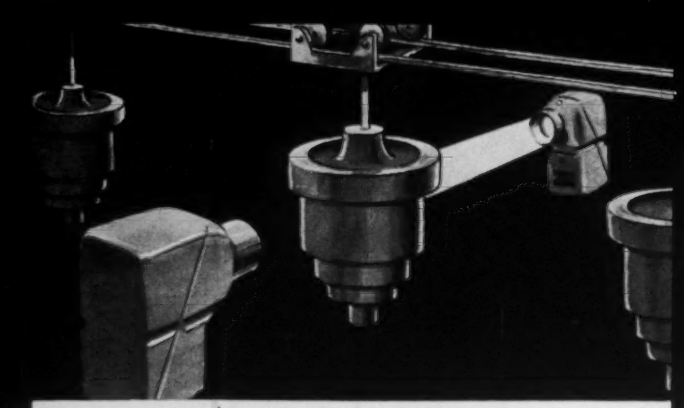
Instruments used in the plant are of the pneumatic type. Miniature receivers are assembled on a graphic control panel in a central control room. From this location, an operator can start up all of the various sections of the process. Once on stream, the system can be controlled automatically in accordance with pre-established conditions set up by the operator.

Significant variables for which automatic controls have been provided include: Temperature and pressure of fuel oil feed; temperature and pressure of oxygen feed; ratio of flow rate of oxygen to that of fuel oil; and flow rate of steam used as a pulverization medium. Another set of instruments enables a strict check of the process balance, and additional devices control or monitor miscellaneous minor variables.

In designing the plant, several problems with regard to measuring and controlling devices had to be solved. For example, checking of inside temperatures of the furnace was complicated by the presence of carbon black, particularly during start up. Wrong temperature data is avoided here through use of radiation pyrometers that are protected by a special sheath equipped with a nitrogen purging stream. Where thermocouples are used, materials that are resistant to high temperature, reducing atmospheres are specified.

Sensors for measuring temperatures of the furnace shell were particularly important since the furnace operates without an outer water jacket. To detect local overheating, thermistor elements developed by Walter Kidde Co. are enclosed in sheaths and welded onto the furnace shell at sufficiently close intervals to permit effective measurement of the temperatures of the entire surface. Whether they are connected in series or parallel,

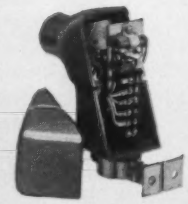
←Circle 681 on Page 35

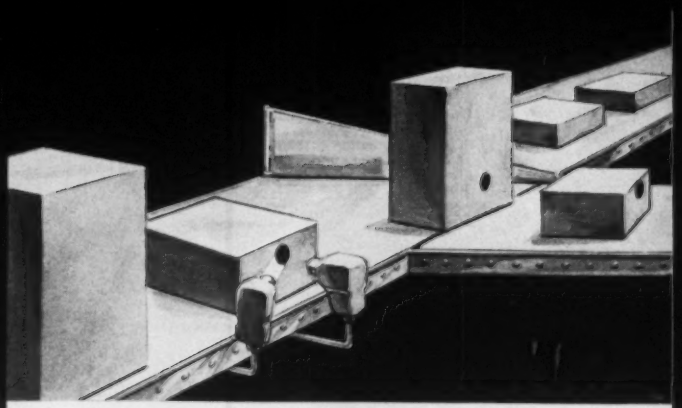


PRODUCTION COUNTING

Problem: Stepped-up production rate made it difficult to count units accurately with existing mechanical equipment.

Solution: Plant Electrician installed two low-cost G-E photoelectric units connected to automatic counter. Even though production units come in bursts of over 150 per minute, this simple counting setup now tallies them swiftly and accurately.

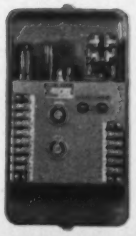


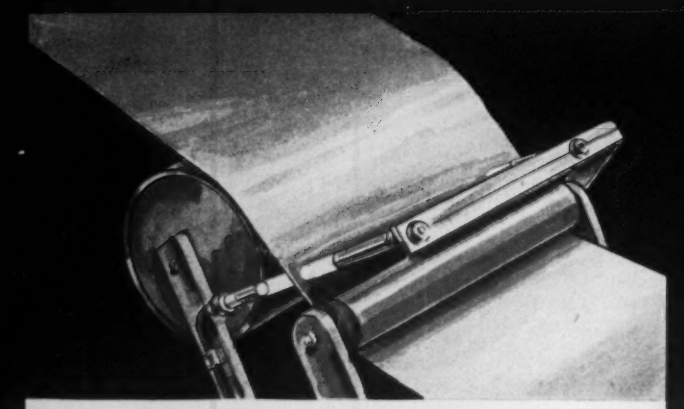


SORTING DISSIMILAR CARTONS

Problem: To automatically divert selected boxes from main conveyor to side conveyor.

Solution: Plant engineer suggested printing black circular marks on those boxes to be diverted. The absence of reflected light from the marked boxes trips the G-E photoelectric units and switches boxes to side conveyor. Unmarked boxes continue straight ahead on main conveyor.

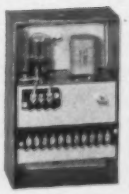


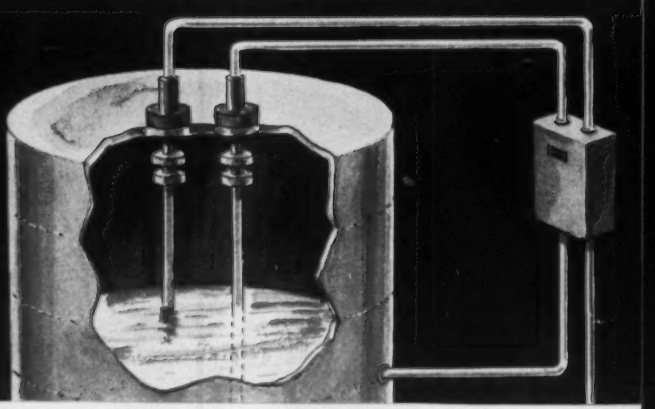


DETECTING WEB BREAKS

Problem: Paper mill experienced excess losses caused by web breaks and decided to investigate automatic detection equipment.

Solution: At G-E Application Engineer's suggestion, plant installed photoelectric web-break detectors. These units detect breaks instantly. Light penetrates through break to scanning photoelectric relay which immediately stops machine.



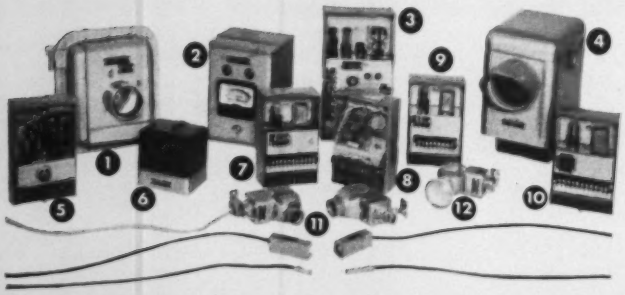


SENSING LIQUID LEVEL

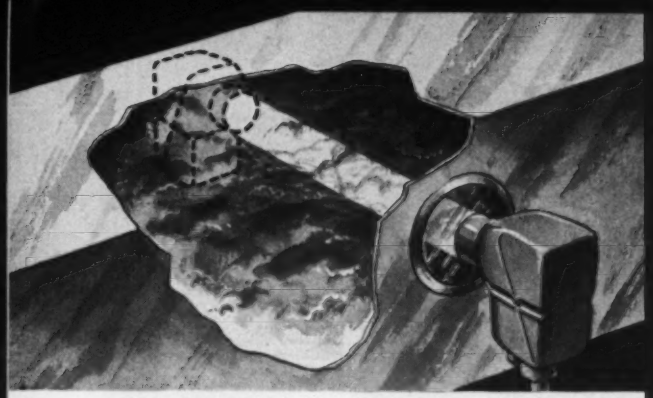
Problem: Brewery planning to add 10 new vats wanted to equip them with most economical liquid level control.

Solution: At the Plant Electrician's suggestion, General Electric resistance-sensitive relays with stainless steel probes were installed on each vat. These standard devices have only one moving part, are easy to install, and require little maintenance.

A complete line of photoelectric and electronic devices for controlling, sorting, limiting,



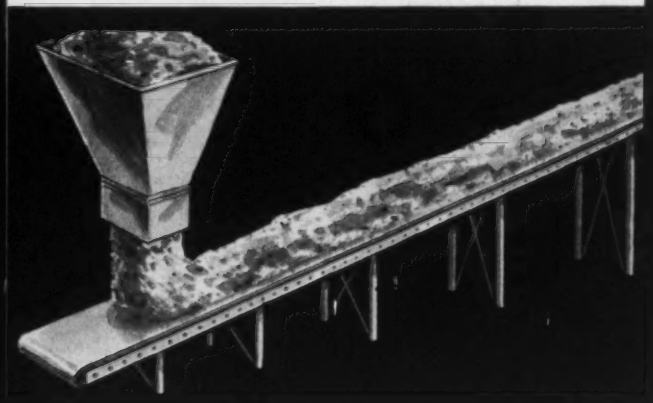
1. **Explosion-proof relay** is high-speed type in special enclosure for use in hazardous locations.
2. **Smoke density indicator** is designed for combustion control or alarm: range is adjustable from 3—100%.
3. **High-speed relay** offers .001-second sensitivity. It also includes time delay and interlock.
4. **Long-distance relay** will operate up to 2500 feet without adverse effects from ambient light.
5. **Voltage-sensitive relay** operates on input signal voltage that ranges above or below pre-selected value.
6. **General-purpose relay** is low-cost, indoor-type photoelectric relay, flexible to operate, easy to adjust.



MEASURING BURNING EFFICIENCY

Problem: To determine that furnace was operating economically, and well within local smoke ordinances.

Solution: Plant Engineer installed G-E electronic smoke density indicator. In addition to performing corrective action, the indicator coupled with a strip chart recorder gives a day-by-day record of burning efficiency. It also satisfies local authorities that smoke is within prescribed limits.



AUTOMATIC CONVEYOR UNLOADING

Problem: Plant wanted to prevent reversing of loaded conveyor upon shut-down of hopper.

Solution: Plant Electrician wired simple electronic timer to hopper switch and to conveyor motor. When hopper closes, timer starts, counts off 45 seconds (long enough for conveyor to dump load completely), then stops conveyor automatically.

counting, and detecting applications

7. New high-speed relay is a low-cost unit for use with miniature or micro-miniature source and cell.
8. Transistorized relay features high reliability with miniature and micro-miniature source and cell.
9. Resistance sensitive relay operates on change in external resistance, ideal for liquid-level control.
10. Electronic timer is dial-set for given time; can be energized or de-energized before the timed interval.
11. Light sources and receivers are available in standard, miniature, and micro-miniature sizes.
12. Self-contained relay is low-cost, compact, tubeless photoelectric relay, ideal for limit-switch-type applications.

Circle 682 on Page 35

CONTROLS FOR AUTOMATION

6 production problems SOLVED with General Electric electronic devices

These six production problems, and hundreds like them, are today readily solved with versatile General Electric electronic devices.

Applied with ingenuity, these devices now help plants sort, divert, detect, count, and perform other operations efficiently. And new uses turn up every day. For instance, the G-E resistance-sensitive relay is often used to control liquid level, but recently, it proved equally valuable as a thread-break detector!

Cash-in on such new uses of these versatile devices by contacting your authorized G-E Distributor early. He can solve many of your problems with electronic devices from stock. And his experience is invaluable on complex applications.

And for additional information on new ways to apply G-E electronic devices, return the coupon for your free copy of GEA-6822. General Electric Co. *Specialty Control Dept., Waynesboro, Va.*

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Please send me a copy of the G-E Electronic Devices catalog, GEA-6822, with description, specifications, and pricing data on the complete line.

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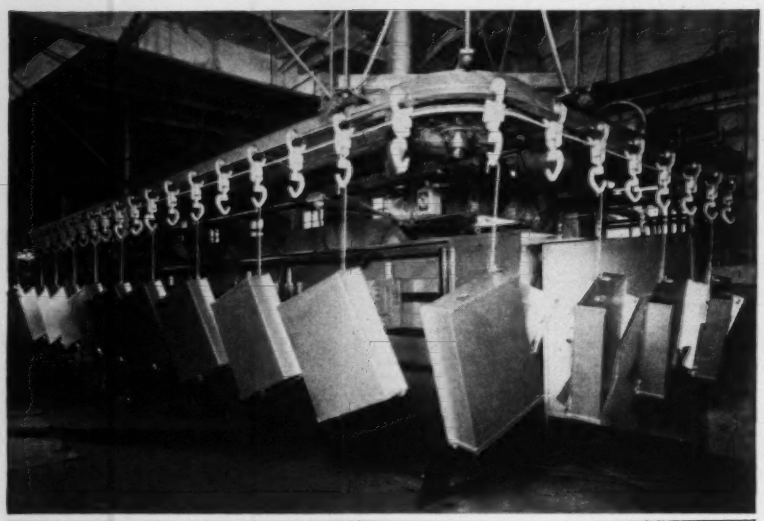

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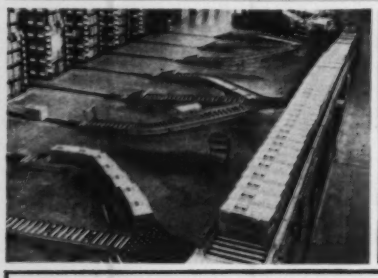

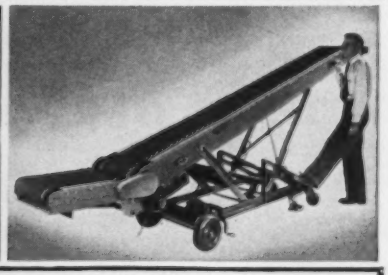

Buschman

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CONVEYORS

Complete Conveyor Systems for all Industries—Engineered, Manufactured, Installed
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366

the sensing elements provide high sensitivity to overheating because of their exponential resistivity characteristics with respect to temperature. A recorder equipped with alarm contacts continuously scans furnace shell temperatures.

An extremely useful index to furnace operation has been found to be the percentage of methane in the gaseous stream leaving the gasification unit. To determine this property, a continuous infrared analyzer is used that gives prompt, accurate results. One value of the instrument is that it enables the prediction of carbon black formation.

Elaborate precautions have been taken to ensure safety in the event of system malfunctions. For example, a series of alarm causes notifies the operator and automatically shuts down the plant or brings it to a safe operating condition. To avoid ambiguity in exactly locating the cause which first started an automatic safety control action, a special circuit has been provided. This circuit enables the identification of the first alarm cause, distinguishing it from the other actions that are set in motion to stop the process.

U. S. S. R.

Viscosimeter that permits automatic, continuous measurement of the viscosities of liquids both at rest and during flow has been developed in Russia, according to a U.S. Dept. of Commerce translation from the publication *Plasticheskiye.* Device uses the principle that viscosity may be determined by measuring the attenuation of natural oscillations of a magnetostrictive probe immersed in a liquid.

Hayange, France

A Prodac (Programmed Digital Automatic Control) system and 42 dc mill motors will be supplied by Westinghouse Electric Corp. for use in a new wide-flange beam mill to be constructed in Hayange. The mill, owned by De Wendel & Cie S.A., of Paris, will feature card programmed operation and includes a 44-inch reversing universal roughing mill, a close-coupled 34-inch edging mill, and a 40-inch single pass universal finishing mill for the production of beams. The Prodac system will allow for three methods of mill operation: Automatic, semiautomatic, and manual.

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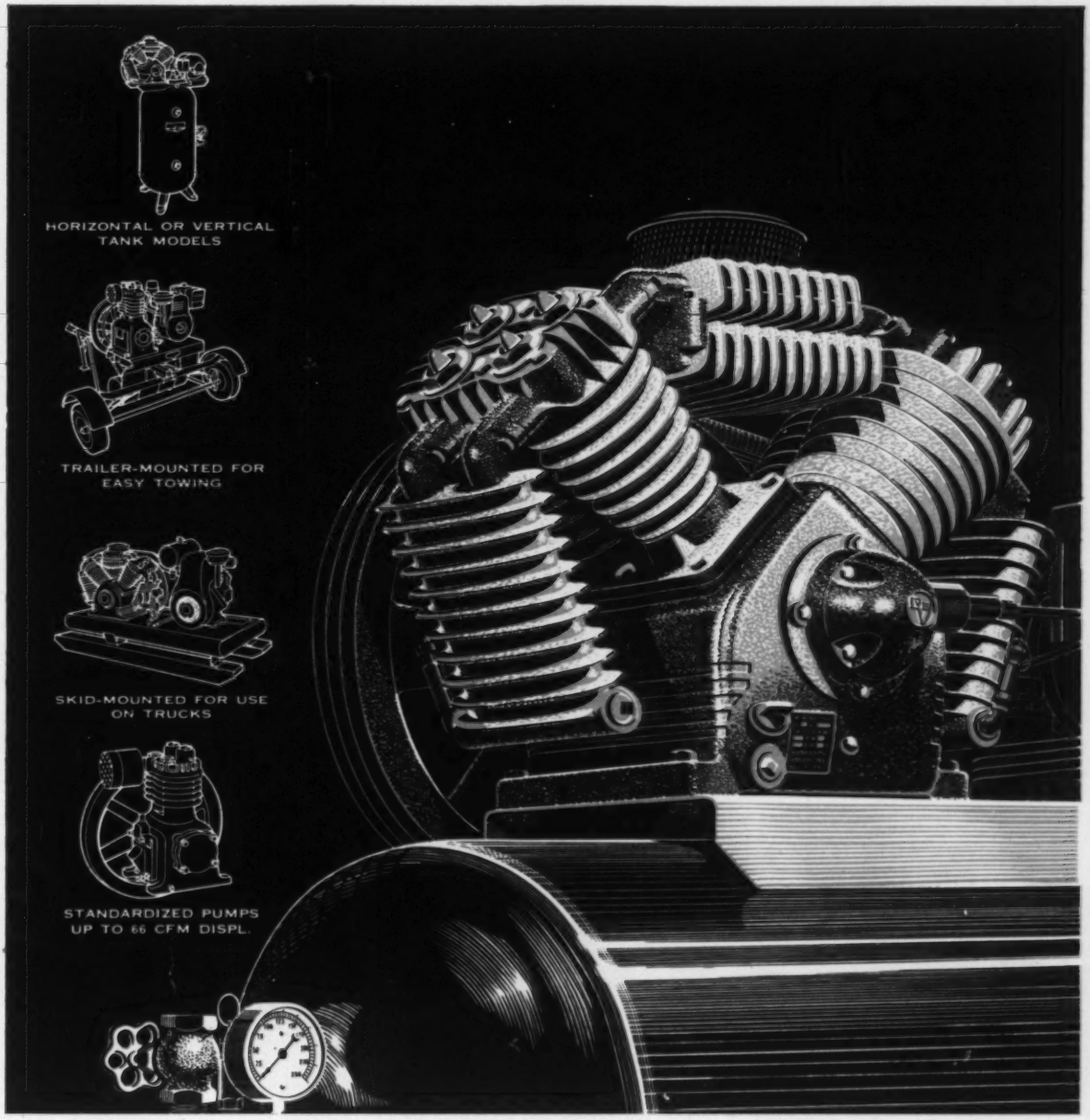
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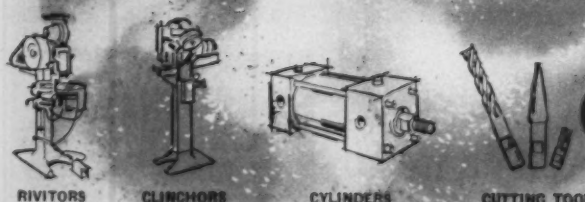
BIG NEWS

The T-J Spacemaker cylinder line is not now, nor ever has been, a probe into outer space. It is offered as a practically designed, research engineered and time tested product. Its Spacemaker feature (no tie-rods) and rugged construction gives greater strength, saves space and reduces costs in all power drive applications. The Spacemaker is available in a complete range of bore sizes and strokes, air or hydraulic, and contains many *plus features* and extras as STANDARD . . . NO EXTRA COST! Write Tomkins-Johnson, 2425 W. Michigan Ave., Jackson, Mich. for Bulletin #155-4 and for full particulars, today.



T-J TOMKINS-JOHNSON
JACKSON MICHIGAN

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AUGUST 1961

Manufacturing Data

EVER since a "Bull-of-the-Woods" first hired a timekeeper to keep track of shop workers and job times, the amount of data involved with manufacturing has been growing like the national debt. Today many factories appear to be manufacturing data as fast as they make products. The age of automation has brought increasing complexities to manufacturing systems, and thereby increased the needs for a wide variety of data handling operations.

Inventory control, production control, spare parts ordering, maintenance control, and actual process equipment control all come under the scope of manufacturing management control and are being served by automated data processing techniques.

Mountains of paperwork are the symptoms of a highly active manufacturing organization. Where the techniques of automating manufacturing operations are causing paperwork headaches, it is encouraging to find that the techniques of automating data processing operations can ease the pain. Automation is the cause and can be the cure.

Whereas computers and their peripheral equipment were once thought of as tools for accountants only, a new pattern of development is seen clearly emerging. Manufacturing management and manufacturing engineers represent the new artisans of data manipulation whose analyses of manufacturing data will spell more profitable plant operations, and broaden the markets for data processing equipment for the control and scorekeeping of automated processes.

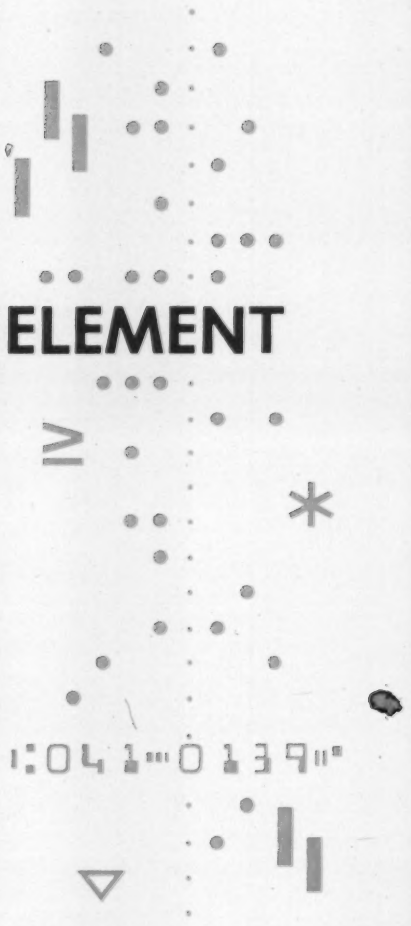
Those who can comprehend and utilize the newly emerging data techniques can study their operations any way they want to slice them, and can determine how to slice them for the greatest profit. This ability to plot future courses of action, rather then merely record historical events makes automated data processing an essential tool for forward-looking management.

James C. Keebler

EDITOR

AUTOMATION

DATA – THE CRUCIAL ELEMENT



Studies of current industrial practices reveal a broad gulf separating backward and progressive companies so far as data handling and management techniques are concerned. Significantly, it is in the progressive companies (already advanced relative to their contemporaries) that new advances continue to be made and new techniques developed. More efficient operations are being sought and found. The conclusion is clear: Efficiency begets efficiency. The implication is profound: A breakthrough to a new level of managerial excellence is imminent.

By J. H. McRAINEY, Associate Editor

DECISION MAKING is the crucial function in industrial organizations—and sound decisions are founded on accurate, timely, and well-organized data. The truism that links data and decision making requires no elaboration. It need only be recalled that of the dynamic forces at work today in the technical, social, political, and economic spheres, all emphasize the importance of arriving at not simply logical decisions but decisions meriting the description "good" and, in many cases, "optimum."

Interest in the problem of decision making has led to investigations and studies which in turn are leading to the creation of an improved management science. Despite earlier claims for "scientific management," until recent years the concepts, techniques, and equipment necessary for the job simply did not exist. Today, developments are occurring with relatively rapid strides in the two independent but mutually supporting areas of equipment for handling data and techniques for utilization of data.

In only isolated instances have organizations been able to develop functioning systems that even partially demonstrate the principles embodied in the new management science. But in many instances, organizations have made noteworthy progress in limited areas. Drawing upon experiences and practical accomplishments of many companies, it is the purpose of this article to highlight trends and considerations in the area of data handling (collection, transmission, storage, retrieval, reduction, and display of data) that are giving impetus to the further development of the science of management.

Need for Significant Improvements

The average company is not unaware of the usefulness of data. With some form of budgetary control, inventory accounting, or sales-production order flow systems there is typically the impression that as much, if not more, is being done as economics permit. But the average company is also faced with stiffening competition, increasing costs, erratic profits, and an increasingly complex technical content in every phase of its endeavors. Of the average

company's goals to meet these problems, none appears compatible with incurring additional data handling costs.

These are times when significant improvements are to be sought. The search for significant improvements is related to the whole complex of advanced data systems and related subjects in the following manner: At this stage of development, utilizing advanced techniques in any given situation does not guarantee that significant improvements will be obtained. But not utilizing advanced techniques does guarantee that significant improvements will not be obtained.

This emphasis on improvements which can be labeled "significant" is more than just a semantic exercise. Consider these comparisons: Confronted with a distribution problem, the orthodox approach might be concerned with where a new warehouse should be located; advanced techniques could suggest ways to eliminate the need for a warehouse, depending on leveled production and goods-in-transit to satisfy requirements. Confronted with the need for expanded output, the orthodox approach would be concerned with what size facility to build; advanced techniques could suggest ways to reallocate production tasks in existing facilities to meet the need. Confronted with a continual pileup of work before a given machine, the orthodox approach would be concerned with the purchase of additional equipment to relieve the bottleneck; advanced techniques could indicate that the real problem was elsewhere in the system, perhaps solvable by the manner in which production orders are released to the shop. Confronted with the suggestion to purchase additional equipment, the orthodox approach could indicate the proposal was uneconomical; advanced techniques could indicate that the economic disadvantage in one area was offset by a greater advantage in a seemingly unrelated area.

These examples emphasize the significant results of decision making. Inherent in the advanced techniques, however, is the use of modern data handling equipment that enables data to be manipulated in order that significant decisions can be obtained. It is apparent though that in what is called "advanced data systems" and "advanced techniques," the use to which data is put is more meaningful than the means by which data is created and manipulated. This is merely another way of restating the often repeated warning that expensive data handling equipment is no substitute for a logical management system or enlightened management think-

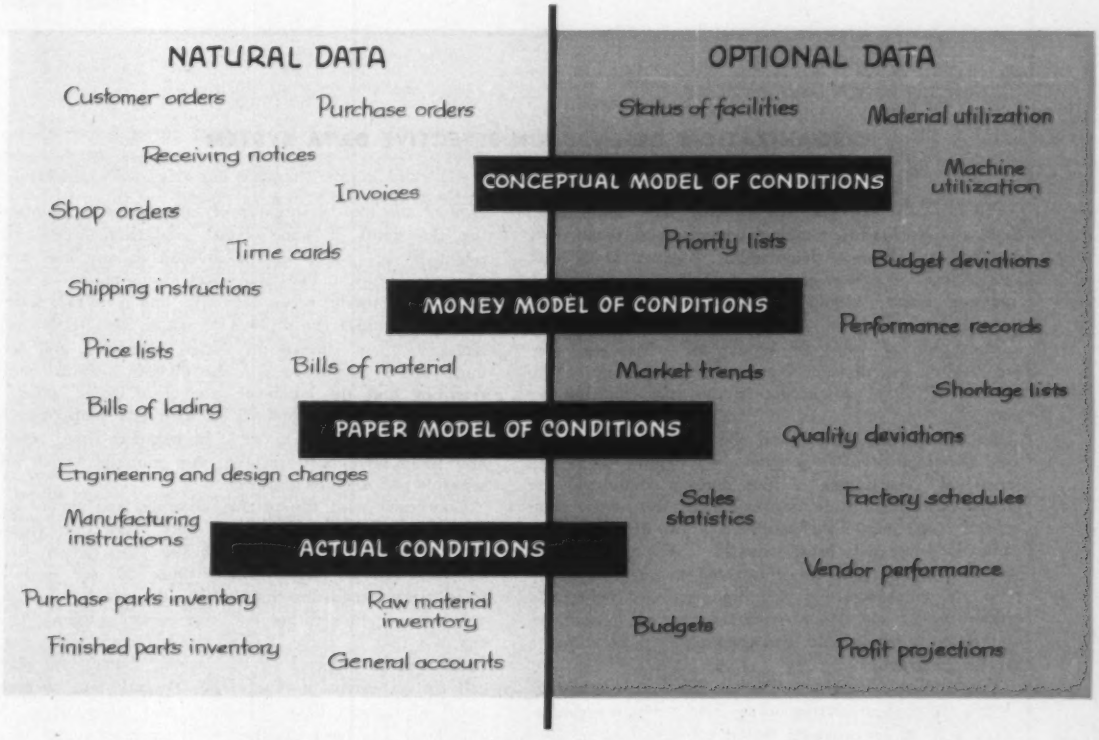
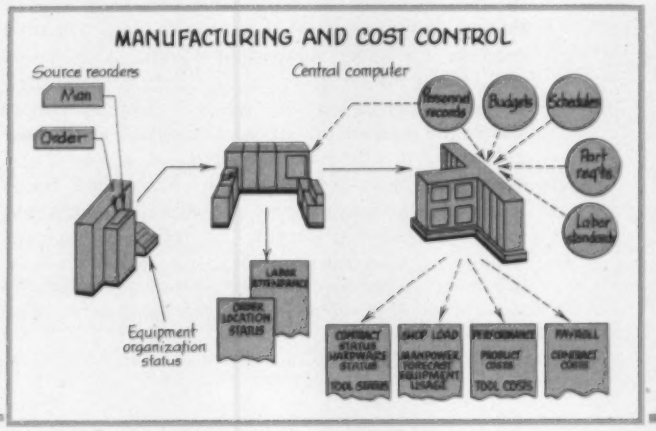


Fig. 1—Data used by industry for administrative purposes falls into two broad categories: Natural data and optional data. As suggested by the diagram, the extent to which a person or group is concerned with the two categories depends upon whether actual conditions, paper models, money models, or conceptual models of conditions are dealt with. Improvements in handling of natural data should be oriented to line personnel who deal with actual conditions. Improvements in handling optional data should be oriented to staff and top management who deal with the conceptual model of conditions.

ing. Successful data handling installations demonstrate that components and equipment are applied because a logical system exists—and not that a logical system exists because components and equipment are applied.

Natural and Optional Data

A manager that desires to share in the benefits of modern techniques must perforce begin at almost the philosophical level in studying his particular situation and requirements. As one steps back to obtain a perspective view of his company's total data problem, he will be able to discern two broad classes of information flow. One is concerned with the natural data of the organization; the other is concerned with optional data, *Fig.* 1. The natural data is that data which must be processed if the organization is to be a viable thing. Included in the natural class are customer orders, invoices, receipts, payrolls, purchase orders—in short, basic data dealing with customer requirements, materials, and money. The optional data is that data processed as efforts to make the organization an efficient thing. Included in the optional class are reports of all kinds, memorandums, budgets, statistical studies, historical files—in short all of the formal and informal administrative aids that abound in any structured organization.



ORGANIZATION DEPENDS ON EFFECTIVE DATA SYSTEM

PRODUCTS manufactured by the Aero Space Div., Boeing Co. include airframe components (both detail parts and major sections), Minuteman, Bomarc, Dyna-Soar, and a host of newer and less related items, including hydrofoil boats. Production requirements range from limited production for research and development to a modest type of full-scale production. Dispersed geographically, the division employs approximately 40,000 persons, 15,000 of whom are in the manufacturing department.

Because of the variety and the necessity of assuring good performance on all programs, throughout the various functional departments of the division individuals or groups have been made responsible for the management of each program. This results in a two-directional organization—one axis being oriented to the typical functional operations, the other oriented to program direction. In manufacturing, this organizational philosophy encourages the adoption of methods, practices, procedures, and concepts which best lend themselves to advancing a specific program.

The company recognized that in developing a variety of new products, in setting up separate program organizations, and in encouraging deviation from typical procedures, complex administrative control and data handling problems were introduced which might be solved by modern technology.

Following some setbacks in early attempts to apply mechanized equipment, a re-examination was made in 1959 of the routine function of following and maintaining the status of some 40,000 production orders that might be in process in the division at any one time. The availability of two new pieces of equipment—a computer with random access capability and a reliable source recorder—enabled the division to obtain an effective system. Frequent changes in design, schedules, and products are a fact-of-life for the division. With source reporting and the computer control of order status, a reduction has been obtained in time and manpower in finding and changing orders. In reducing time, rework and scrap have been reduced, raw material saved, and schedule performance improved.

Concerned with the precise, accurate, and timely collection of manhours in detail part fabrication (fabrication manhours have, within a few years, grown from 12 per cent to slightly more than 50 per cent of total direct production manhours), the division has developed a manufacturing and cost control system. It is expected that by early 1962 all direct factory labor manhours will be collected by the system. Subsequent plans call for an extension of at least the collection of manhours of indirect labor in factory and office areas. As experience has been obtained with equipment and techniques, the magnitude of the concept of a manufacturing and cost control system has broadened to that of a means essentially to tie together related operations of the finance and manufacturing department.

Another system, in the final stages of installation, has

Not all data is clearly identifiable as being either natural or optional. Some optional practices have become so time-honored or so enmeshed with natural data that they appear to be necessary. Accounting practices, in particular, have a penchant for solidifying with time into set practices.

The value of distinguishing between natural and optional data lies in clarifying the picture when changes in data systems are contemplated. Expenditure of time, effort, and money on well-thought out improvements for the flow and handling of natural data can be justified in a straightforward manner. Fundamentals are being dealt with and the basic processing of natural data must occur.

Improvements involving optional data are another matter. Before deciding whether humans or equipment shall be used in processing optional data, it must first be decided whether or not it is really necessary to process it at all. When one examines optional data systems he is quite soon confronted with divergent opinions as to the usefulness or appropriateness of given practices. The roots of the problem reach deeply into the organization of a company. The conflicts are a consequence of the personalities of the men chosen by management for key positions, the way responsibility has been divided, the extent to which authority is delegated, and the manner in which accountability is assessed. These are key factors that influence such aspects as jurisdictional squabbles, need for exchange of information, extent that data is duplicated, frequency of reporting, degree of formality required, type of filing systems maintained, etc.

Artificial Boundaries

In searching for improvements in administration and data systems, most companies are confronted with a paradox: The typical departmentalized organization is designed to make the organization efficient yet it contains structural flaws which contribute to inefficiencies—and it is singularly sensitive to such imponderables as personal tastes and human relationships.

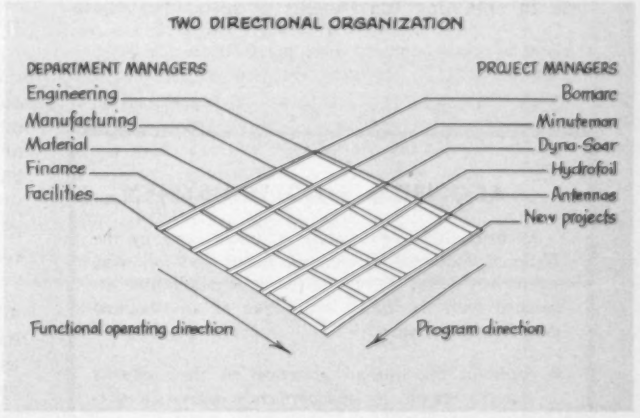
As to a fundamental flaw, it is often overlooked that there is a natural tendency for any distinct social group to be primarily concerned with its own welfare. Among other results, this natural tendency is easily interpreted as a basic need for the social unit to protect and perpetuate itself. Functional divisions within a company can become so sizable,

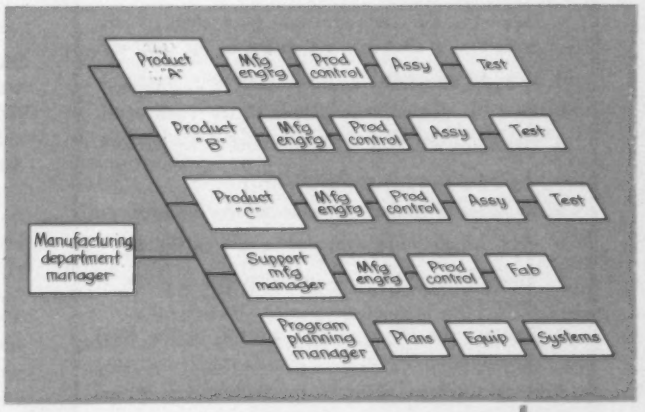
been developed to tie together the related elements of product design engineering, material, and manufacturing departments. The Parts and Material Accountability Control System combines certain operations previously mechanized and other operations performed manually.

With the establishment of source recorders throughout the plant and transmission means that couples the recorders to a central computer, it is envisoned that the basis exists for the further development of various other data systems. Reliability requirements of missiles, in particular, have created problems that can only be handled by a mechanized system. As an example, a means must be devised to find a specific, serial-numbered etched circuit card at any given time from receipt of the component in the plant, through installation of a piece of gear containing the component at a missile base.

Certain guides have been established for future systems development: 1. Each system design will be aimed at the objective of providing better control of manpower, facilities, and material. 2. New systems will be designed singly but in such a manner as to fit into over-all planning. 3. Each system will be designed with careful consideration of these factors: Status of inputs must be current; reports presented to managers will be of the summary or exception type; and data transmission and collection devices will be used extensively.

Another important point identified by C. E. Sheldon, Asst. Mfg. Mgr. is that responsible managers must be prepared to make full use of new tools as they are developed (such items as computer display devices that permit transmission of graphic reports to managers are examples of potentially useful tools).





tightly organized, inbred, or encouraged by mismanagement that they assume the proportions of a separate, self-sufficient social group. Thus there can be established a basis whereby, in the normal conduct of business, personnel at all levels of functional groups act and make decisions from the limited viewpoint of their department or section. The average decisions that are made can rate rather low on the quality scale so far as the company as a whole is concerned. Indications of this are the five figure annual dollar savings that some companies have reported as a result of revamping internal administrative procedures to consolidate reports, use multipart forms, or other equally simple improvements.

Controlling this inherent selfish instinct requires constant management effort. In the future the problem will be even more severe. History indicates that all functional activities are becoming more technical in nature, thus accentuating the differences between the functional groups at a time when their potential usefulness is increasing. Developments in both equipment and techniques have not occurred evenly in the several traditional functional areas—another factor leading to an imbalance of management attention to elements in its over-all organization. Management is faced with no easy task in obtaining the benefits of specialized equipment and knowledge in some balanced manner that advances the company as a whole.

Most managements readily and successfully create new sales groups and engineering project teams when it is desired that progress be assured. This suggests that the elements of the ideal company structure should be organized around objectives as opposed to the somewhat common practice today of organizing around techniques.

The distinction between the two approaches is comparable to arranging equipment of a common type into a department (technique-oriented) and arranging a variety of types into a line (objective-oriented). In-line arrangements erase arbitrary functional boundary lines between equipment. In a similar vein existing boundary lines between functional groups should no longer be considered inviolable so far as the creation and use of data are concerned.

The form of organization that will develop from these considerations is not clear. Present practices appear to make use of a variety of approaches: Redefinition of responsibilities, creation of new functions, and the use of committees, task forces, study teams, and staff consultants. Whatever technique is used, attention must be focused on the major problem of today: Obtaining a superior co-ordination of efforts directed toward the best interests of the organization as an entity.

ACQUIRING A MODERN SYSTEM

AS determined by a study of installations by the National Industrial Conference Board, the following points best define the administrative responsibilities associated with the initial acquisition of an advanced data handling system:

- Ascertain the over-all objectives of the company and the reasons for management's interest in electronic data processing.
- Determine the best approach to a study of the feasibility of electronic computing in the company.
- Delegate responsibility for the feasibility study.
- Plan the general organization of the study team.
- Determine the kind of information to be gathered.
- Evaluate the results of the feasibility study.
- Recommend a course of action to top management.
- Plan the electronic data-processing organization.
- Establish a program for selection and training of personnel.
- Evaluate the efficiency and progress of the data-processing operation.
- Allay the fears and gain the co-operation of employees.

Data Goals

In the manner that structure should be an adaptable attention-focusing tool, the data handling system should be an adaptable network for the flow of information to be shaped to the needs of an organization as a whole. Consistent with obtaining needed information, improvements involve a judicious blending of sometimes conflicting but always related goals.

For example, the actual usefulness of information, and hence data, can be measured against a time scale. All would agree with the general propositions that some information is as useful today as it was years ago; that some information becomes useful only with the passing of time when it can be correlated with additional information; and that other information has a peak usefulness early in its life, falling off in value as time passes. What is not always remembered by all is that the time-usefulness picture for a given piece of information differs considerably according to the recipient of the information.

The major goal in obtaining an improved data handling operation is to put pertinent information into the hands of appropriate decision-making authorities within time limits that allow the peak potential usefulness of the information to be realized. The relationship of this goal to the organizational structure is apparent: Organization establishes the appropriate decision-making authorities and influences the time which is required for processing various types of data.

Another important goal is to reduce to a routine

DATA SYSTEM GEARED TO OPERATIONS PLANNING

SPEAKING before the 29th Annual Conference of the Controllers Institute of America, H. W. Crandall, manager, Electronic Computer Center, Standard Oil Co. of California, had this to say about his company's conception of how a computer should be used:

"One major incentive in Standard Oil, as we approached the computer, was to improve the planning and control of our operations through computer simulation methods. By developing mathematical models of major operations in our business, we visualized that they could be run on a computer under varying business assumptions and operating alternatives—to simulate the effects of our assumptions, to help choose preferred operating alternatives, to thus improve our over-all performance.

We installed a large computer . . . for this purpose. At the same time, we undertook exploratory ventures on smaller equipment for such purposes as payrolls, dividend accounting, personnel records, and the like. Our approach into the clerical data processing field was more cautious because we felt that the largest payout for use of the computer was in operations planning and control. This approach contrasts with that of many commercial firms which first undertook clerical accounting data processing and then, as experience developed, proceeded more gradually into operations planning.

Our approach has paid off. *Measurable advantages amounting to hundreds of thousands of dollars have resulted from each of a number of business simulations that we have conducted* (italics added). These advantages have come by enabling management to carry out improvements in the conduct of operations and from the attendant operating cost and raw material savings. In addition, many intangible benefits have accrued from more comprehensive and exact analytical studies which underlie our operations planning. . . .

Our operating simulations have ranged into many areas of our business. Mathematical models have been developed for major oil fields, refineries, and distribution systems. Both existing operations and proposed operations, including new facilities that are contemplated, have been studied, both from the viewpoint of the flow of materials and the resulting cash flows and profitability.

To summarize a few of the major things we have learned from our work in the computer field:

1. Our approach of emphasizing the operations planning for use of the computer is practical and sound.

2. Good descriptive mathematical models of our major operations can be developed. They describe the operation sufficiently well so that their use on the computer simulates the operation.

3. Use of these models for simulation of operations is a profitable management tool.

4. The most important ingredient for success in this work is the ability of the analysts, computer experts and operating people to work together to prepare the models.

5. Key variables, not quantifiable, remain apart from the model in the hands of management. As a result, no single magic answer or operating plan comes from the simulation; rather, that portion of the operation that can be quantified is well defined for the management decision process.

6. As a practical matter, once models are developed, we must remove the computer experts to the sidelines and place the operating management as directly in touch with the model and the computer as is possible. This is achieved by having the computer accept the operating language and, in turn, prepare reports and analyses in the operating language. . . .

7. In computer acquisition the largest system that can be justified in relation to anticipated workloads should be acquired. This results in the lowest unit work cost and has the plus value that adequate capacity exists to conduct exploratory-type applications. . . .

Most of our simulation work has been geared to single operating areas of our total operation. These areas, while large in themselves, are small in terms of the totality. We can expect to find simulation broadening in its scope until it covers virtually all determinable or controllable phases of our business. The more powerful methods of optimization, such as linear programming, will come in for even greater emphasis. . . ."

as much as is possible the decision making that must be performed as a result of data flow. For a routine to be good, it must be simple and well thought out. It becomes a sort of "frozen decision" or "decision making by proxy"—in short, means by which a management can exert a direct influence so that straightforward situations are handled as management itself would have handled them. An important byproduct of good routines is that pertinency of information can be identified, thereby relating the establishment of routines to the major goal of getting proper information into the proper hands.

Continually studying operations to obtain more comprehensive routines is an honorable and worthwhile management pursuit if management benefits by obtaining time to devote to its major task of providing for the future. If routines are thought of as a "frozen decision" technique to bring management closer to hour-by-hour operations, then managers might be more inclined to periodically review and update routines before being forced to do so by gross inefficiencies.

Somewhat related to the establishment of routines is the goal of developing decision aids. Decision aids might be thought of as studied expressions of the relationship of variables which should be considered in obtaining consistently good decisions at all levels. Whether or not consciously aware of it, all managers develop such aids to some degree based upon experience. However, the rapid changes in technology and the importance of correctly relating developments to the future welfare of an organization preclude the use of trial-and-error in amassing experience. The modern approach suggests that relationships of variables, previously unsuspected or considered impossible to know, can be determined and manipulated to improve decision making.

DATA-THE CRUCIAL ELEMENT

Most of the newer techniques for developing decision aids depend on mathematical concepts that border on the novel so far as the average manager is concerned. Thus, there is created the ever ticklish problem of the successful man with years of practical experience being called upon to evaluate or adopt relatively complex techniques expounded by less experienced persons. Whatever else a responsible manager feels about advanced thinking in the managerial field, it is important for him to appreciate that significant improvements are being made in decision-making techniques and that his competitors might very well be making use of them.

Four Domains

In the light of these general goals, the general role of equipment is apparent. Equipment can speed the handling and transmission of data, making it possible for peak usefulness to be realized. If good routines have been established, equipment can handle the processing of data, with improvements typically noted in speed and accuracy. Equipment can be used to carry out complex calculations and data manipulations in developing decision aids.

In addition to classifying information into a natural or optional grouping for study purposes, information flow can be conveniently divided into four broad functional domains: Service domain, reference domain, planning domain, and control domain, *Fig.* 2. In this context, the service domain is primarily concerned with the processing of the natural data of a system. The reference domain covers the collection of data considered too important or too complex to be left to chance remembrance. The planning domain is concerned with the capabilities and goals of the organization relative to the future and possible courses of action. The control domain is concerned with the implementation of plans and the short-time adjustments demanded by practical considerations.

This grouping suffers from the shortcomings of any such artificial classifying scheme that suggests there is a sharp distinction between members of a complex family. But on the plus side, it does focus attention on general areas of modern day equipment application, enabling applications to be viewed in perspective. The four domains can be identified in any organization. However, the extent to which equipment has been applied in each domain varies considerably, depending primarily on the types of products or services dealt with, the size of the organization, and method of marketing.

Service Domain

In sheer numbers of data equipment applications, the most attention has been given to the service domain. Updating customer's accounts, reporting transactions, receiving sales orders, making out payrolls, preparing purchase orders and invoices, and similar handling of natural data must be performed. Two points stand out: A great deal of the natural data is commonly useful to various parts of an organization, and the data handling is repetitive in nature. In short, handling the natural data of an organization is particularly susceptible to being aided by equipment of some form.

It has been recognized that the key to improvement in the service domain is the earliest possible transcribing of data onto a medium readily usable throughout an organization. For the average company, significant improvements are centered around such devices as point-of-transaction recorders and other types of equipment that provide a machine-readable record as a byproduct of normal data processing. Using punched tape as but an example, data can be recorded on tape as a byproduct of operating a typewriter, adding machine, calculator, cash register, etc. Subsequently, the tape can be used as an input to various kinds of printout equipment or to communication equipment for transmission of information over a distance. Equipment is also available to convert the data on the punched tape into other machine readable forms, such as punched cards.

In the typical system, data is originally entered on multipart forms or reproduced in sufficient printed quantities for distribution to interested parties. Analysis of data entered on such forms will generally reveal that even earlier transcribing of a great part of the data is possible. This has led to the use of punched tape, punched cards, edge punched cards, punched tags, embossed plates, magnetic ink printing, and optically-read codes to record fixed data. Variable data is added to the fixed data as needed to create a complete entry.

As an example, in manufacturing, fixed data associated with established customers' orders (names, addresses, account numbers, shipping instructions, sales credit, etc.) is prepared ahead of time. Upon receipt of an order, this recorded data can be fed into a machine that reads it and that can also accept variable data for the particular order. The output of the machine can be a document, another machine readable media, or electrical signals that can be transmitted to remote locations. As a further refinement, prerecorded data from a customer's order can also be distributed ahead of time to production facilities, providing an accurate basis for later reporting of completion of work, labor hours expended, material withdrawals, shipments, etc.

The economic basis for the use of equipment processing data in the service domain is in the improved accuracy of reporting transactions, time saved by eliminating repetitious transcribing of the same data, and the readiness with which the recorded data can be transmitted and manipulated in various phases of the processing cycle.

This latter advantage has been used to justify computers in the service domain, most often in accounting and inventory activities. In particular, insurance companies, banks, and similar types of com-

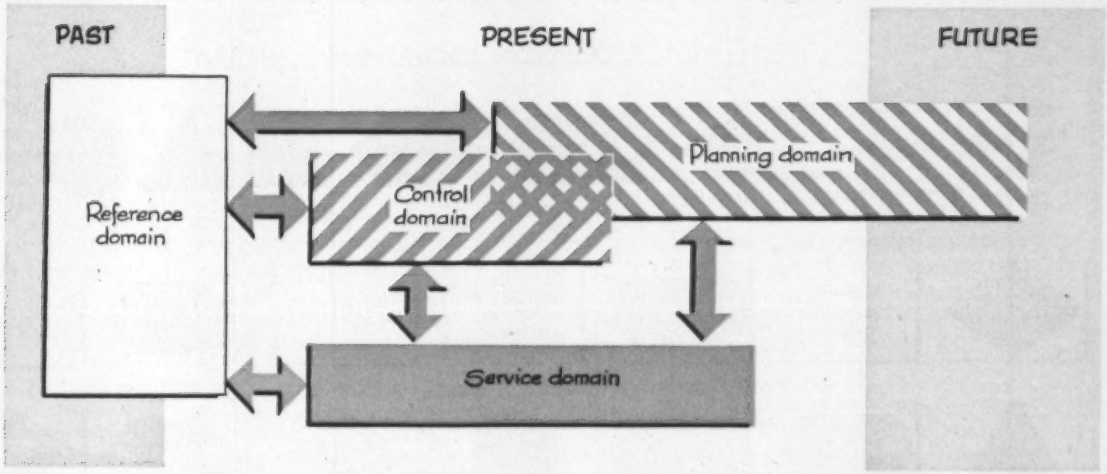


Fig. 2—Data processing for administrative purposes can be thought of as involving the four domains shown in the diagram. Depending on the type of industry, adoption of new techniques and equipment has proceeded unevenly, with one domain or the other receiving the most attention. Lacking the extreme conditions which leads to concentration in a single domain, the average company must strive for a balanced data handling system that can contribute value in all four domains.

mercial activities have been able to use computers for the processing of natural data.

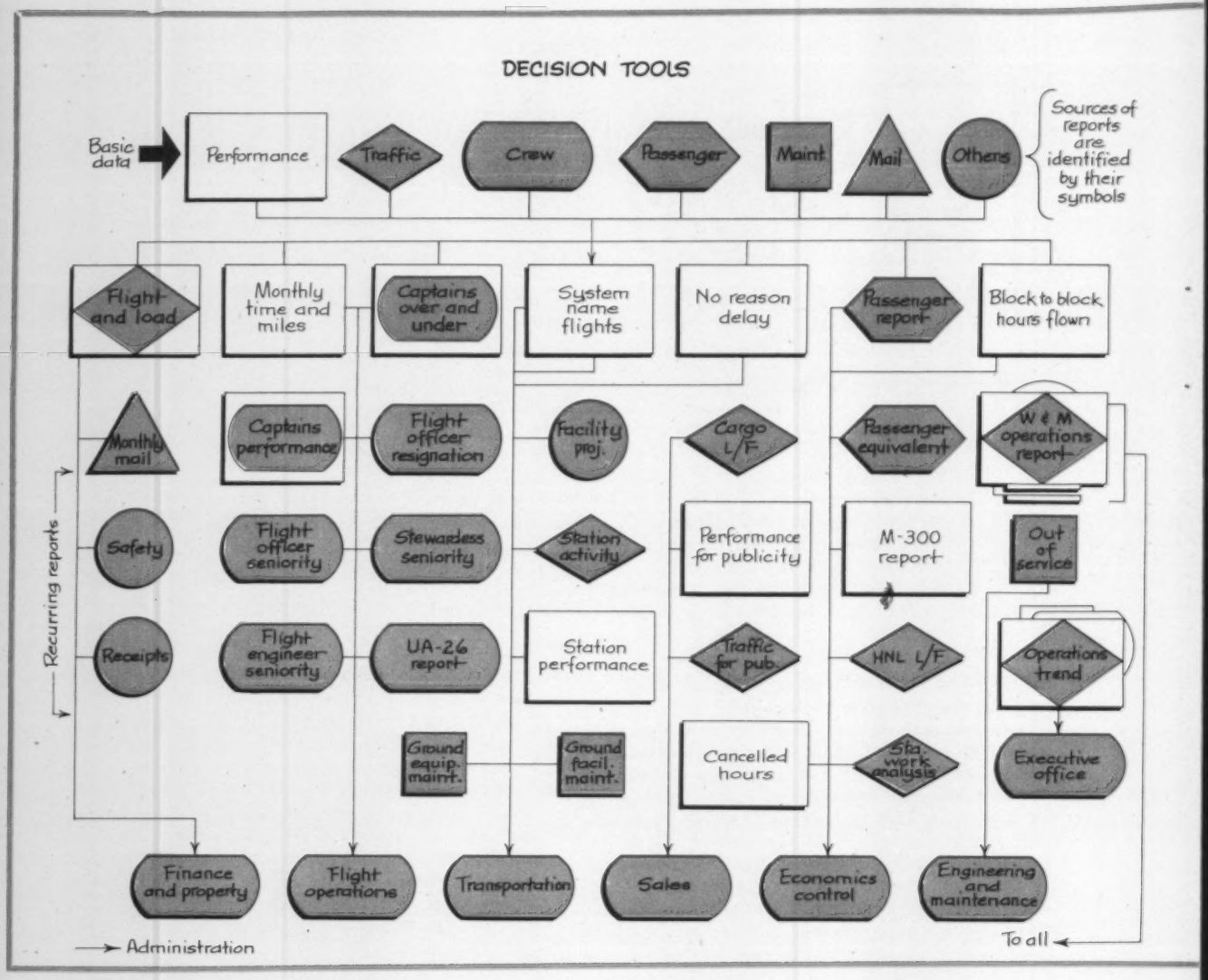
It is not unusual for a bank or insurance company to be faced with daily updating of several hundred thousand accounts. The problem is one that demands ultrafast handling of data. Anticipating the need to process upwards of 20 billion checks per year within the next few years, banks have also begun to adopt special check handling equipment. The development of MICR (Magnetic Ink Character Recognition) equipment and application standards is not only noteworthy for technical reasons, it also illustrates major improvements which can be mutually obtained through co-operation.

In the manufacturing area, the usefulness of a computer can be illustrated by a system at the Bell Helicopter Co., division, Bell Aerospace Corp. The system integrates the major operations within the company including the functions of buying, receiving, storing, production, shipping, billing, and manufacturing accounting. Eventually it is planned to include other activities such as shop loading, labor forecasting, statistical quality control, and production simulation.

The system revolves around master files on magnetic tape and punched cards. For example, from part and assembly list files, new orders can be translated into detail schedules for materials, parts, and subcontracting requirements. New requirements can be determined by comparing gross requirements to inventory, on-order, and in-process files. Previous suppliers, subcontractors, prices, and action documents can be obtained from a purchasing file. The identification and location of tools required by production can be obtained from a tooling file. The computer also produces documents to direct the flow of materials and jobs to the desired manufacturing or assembly stations in accordance with a master schedule. Exception reports are prepared by the computer for management guidance. The company estimates that computer techniques have helped to recover $500,000 in capital previously tied up in inventories and anticipates that eventually manufacturing paperwork requirements will be cut in half.

Not all computer applications have been as successful as anticipated in industry. The trouble appears to be caused by attempting to turn an isolated department activity into a mechanized island within a sea of conventional practices. The effort and cost can exceed that expended on a well-organized manual system. In short, when it comes to using the more expensive and exotic computer based systems in the service domain, more than the usual amount of attention must be devoted to choosing the area to initially mechanize. A straightforward and obvious application (such as preparing the payroll) might be relatively simple and it might eventually result in some savings. But if the results do not contribute to significant improvements in the operation of the over-all organization, it is undoubtedly a poor use of modern equipment.

For administrative purposes, a great deal of optional information can be created from the flow of natural data in the service domain. Information can be summarized and compared to standards, budgets, and goals, in a myriad of ways to enable management to better visualize activities. It is obvious, however, that the usefulness of such approaches depends upon the thoroughness and precision that goes into the preparation of the yardsticks by which the activities are measured. If the yardsticks are anything less than excellent, any significant amount of money spent on summing up the natural data will be largely wasted. This subject encroaches upon the control and planning domains, but it does suggest that the power of data



processing equipment might best be applied initially to the problem of creating effective yardsticks rather than simply mechanizing existing practices.

Reference Domain

The reference domain overlaps other domains because the ability to store and recall data is critical to the support of all comprehensive data systems and to the rapid manipulation of data. In modern systems, data storage units are modular items which can be added in sufficient numbers to obtain the desired capacity. Magnetic tape units, magnetic drums, and magnetic disks are principally used. A major breakthrough in administrative data processing occurred when equipment manufacturers developed memory equipment with random access capabilities—a necessary attribute if equipment was to become a tool for control of current events.

Aside from well-known applications where stored data can be compared to ledgers, accounts, or lists, there are additional important areas worthy of note. For example, in the engineering and scientific areas not only must numerical type data be stored and recalled but also great masses of information in graphic and documentary forms. When one considers the frequency with which files must be searched for a piece of information or the time consumed in reviewing the literature of a certain subject, it is apparent that the advances in information and document retrieval are potentially useful to all organizations.

Handling of information in graphic form is often overlooked when improvements in data processing are considered. However, engineering sketches and drawings and detailed parts lists will be used by the sales, engineering, production, and service functions for quite a while longer. As such, the various types of equipment developed for processing, handling, viewing, and enlarging microfilm have an important role to play in progressive organizations.

GRAPHICS EMPHASIZED IN REPORTING CURRENT DATA

TO KEEP management informed and in control of its extensive operations, United Air Lines has established a computer-based data handling system. With reference to the management control aspects of the system, J. A. Murphy, Statistics Manager, has stated, "We are endeavoring to minimize the detail going across the executive's desk by maximizing the use of over-all indicators which are very sensitive and which can be quickly substantiated by mechanized summaries of pertinent information."

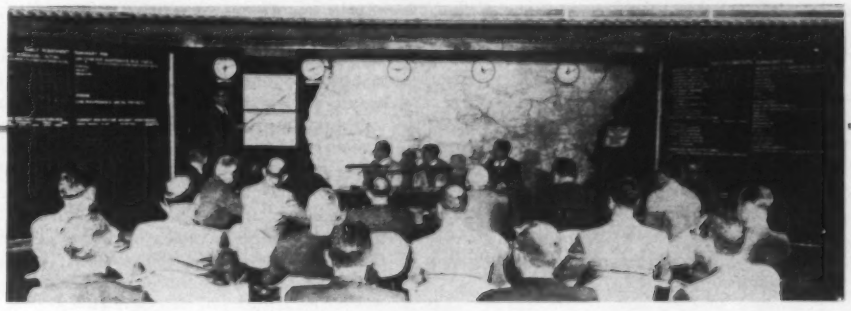
Emphasizing current reporting using the minimum of source data, the data center at Denver receives as inputs two field messages (load dispatch and flight movement) for each of approximately 1000 daily departures of aircraft throughout the United system. Reports are received, on the average, within 20 minutes of each departure. The field messages include complete identification data (trip number, date, equipment used, crew, etc.), revenue data (passengers, weight of mail, express, freight, etc.), and performance data (ground delays, reasons for delays, departure time, arrived time, etc.). From these messages, current management reports are obtained. For example, by 9:00 each morning the president of the company is presented a profit or loss operating report covering the previous midnight to midnight period. Also, 140 different management reports are compiled each month for the benefit of the different organizational elements.

In addition to this orthodox reporting based upon the field messages, key management personnel are kept abreast of current activities by a unique daily briefing. Each morning, a 10 minute briefing is presented on irregularities, traffic, and performance for the previous 24 hour period (midnight to midnight). The briefing is conducted by managers responsible for Weather Service, Aircraft Maintenance, Customer Service, and Operations Planning. With the exception of questions for clarification, no discussion occurs. Following the 10 minute briefing, individual administrative staff meetings are held in which problems are discussed, solutions arrived at, and policy decisions made.

Once each week following the daily briefing, a summary of the previous week's performance is presented by a senior analyst. The weekly analysis is essentially a presentation of graphic charts covering each important area of operation. Accomplishments are compared to historic norms, profit plan, and trend lines. This too is a brief 10 minute meeting. The Denver presentation is tied by telephone to United offices in San Francisco and Chicago, duplicate charts being displayed at the three cities.

The emphasis on graphics in management reporting is evidenced in other areas. For example, in the briefing room, various charts display quality control data concerning current equipment and system performance. A wall size map in the briefing room has been provided with lights to indicate certain weather and performance conditions at key terminals. A more refined analysis of performance in the forms of monthly and annual trends is charted for display in the company Board room.

This application of a computer to current management reporting is but part of the total picture of United's effort to use modern techniques. The company has adopted the philosophy that modern equipment should perform part of the operations rather than simply keep score on operations. To this end, an extensive electronic reservation system has been developed and the company has pioneered in use of simulation studies in analyzing operational problems.



A common meeting ground between other data processing and graphic data processing is provided by aperture cards in which individual frames of microfilm are mounted in business machine cards. Graphic data processing has also benefited from advances in television. Not only can closed circuit television be put to good use in some applications but also magnetic tape techniques for recording, storing, and reproducing pictorial data would appear to offer special advantages.

As an example of an advanced system, Westinghouse Electric Corp. has established a data processing center to serve research, sales, design engineering, manufacturing, and accounting functions. Among the programs developed to date is mechanization of customer order development for the Assembled Switchgear & Devices Dept. Equipment produced by the department is essentially assembled from predesigned components into special configurations to meet each customer's requirement. From engineering information describing a particular order, computer processing results in such data as ordering information, assembly information and requisitions, bills of material, instructions for punch press operators, and a drawing of the equipment. The drawing is prepared by an X-Y data plotter and is converted to a useful document by a microfilming operation in which title blocks, column headings, etc. are added.

Recording, storage, and retrieval of written

knowledge is of undeniable importance when the rate of expansion of technology in all fields is considered. The actual money value can only be estimated, but certainly the total amount of duplicated efforts, both successful and unsuccessful, that are applied to problem solving and research projects must reach staggering proportions.

More and more companies are beginning to realize that there is a possibility of creating a valuable company asset by collecting and organizing in a readily usable form available technical data from journals, papers, theses, and books. In some industries, information retrieval is recognized as a common problem to all companies, and accordingly, investigations by industry associations have been established. Notable in this regard is the American Society for Metals' program with the Center for Documentation and Communication Research at Western Reserve University.

It would appear that present theoretical studies in the field of information coding and organization of information for retrieval will result in additional important advances. Whatever the future holds, it is probable that the techniques will be related to the capabilities of data processing equipment used in other domains. As such, this important aspect of data handling should receive considerably more attention in the coming decade.

Planning Domain

It has been suggested that the primary obligation of management is to provide for the future of their organization. Including the future in calculations certainly introduces a variety of unknowns. However, in some respects the future is not as complete an unknown as one might first suspect. For example, it has been pointed out that the machines which will be offered for sale in five years are on the drawing boards now. The new materials and new processes which will be an-

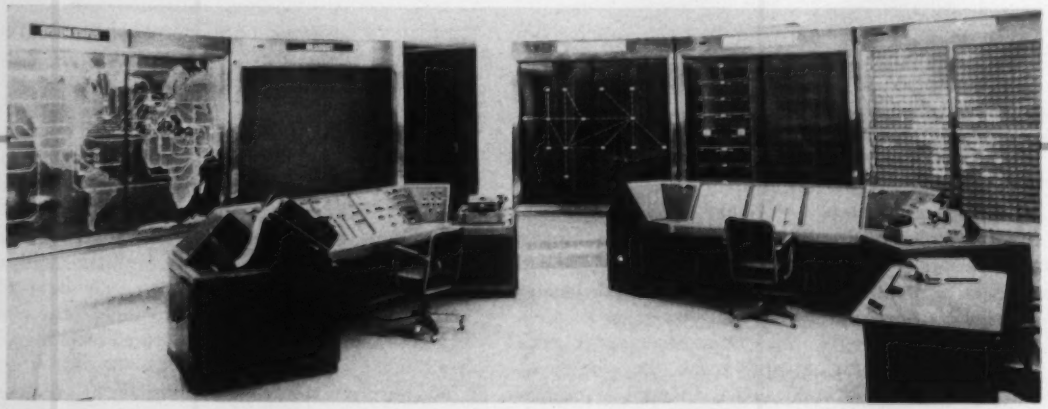
UNIQUE DEFENSE APPLICATIONS ANTICIPATE FUTURE

LARGEST user of both special and general purpose data handling equipment is the Government of the United States. Throughout its various departments and agencies, computers are used in applications comparable to those in industry: Inventory control, payroll calculations, scientific calculations, data reduction, etc. In other areas, particularly those concerned with defense requirements, unique applications and equipment can be found.

Included among the unique applications are systems with real-time capabilities. Equipment complexes range in size from huge, fixed installations for the defense of the North American continent to small, mobile centers for guiding a battlefield commander. These various systems are of general interest because they will undoubtedly influence the development of equipment and techniques for future industrial use.

It is in this sense that the pictured Defense National Communications Control Center is noteworthy. The general task of the Defense Communications Agency is to exercise operational control and supervision over a world-wide, non-tactical communications system for the Army, Navy, and Air Force. To accomplish this, a complex of communication control centers are to be established. Heart of the control center complex is the illustrated installation which is designed to accept information about communications traffic and system status throughout the world.

To provide instantaneous status information for decision-making personnel, a unique display system has been designed. More than 17,000 illumination sources are contained in the displays. Information presented on the panels includes such data as trunk status; assignment and availability of individual circuits; station status; and the scope, priority, and quantity of message backlog. Multicolor presentations, unique shapes, and positions are used in the display panels to present the data. The display panels were developed by the Philco Corp., who also supplied the Philco 2000 electronic data processing system around which the display complex was built.



nounced in ten years are already in the test tubes. All of the engineers, research workers, economists, and workmen who will participate in industry during the next twenty years have already been born. Isolating similar indicators significant to the future of an organization is an important phase of management research.

However murky the total future appears to be, certain elements associated with planning are within management's control—the establishment of goals for the organization and the forms of the organization. Advanced thinking recognizes that the proper goal for an industrial organization cannot be simply defined as "making a profit." A number of other important factors are to be considered if the future is to be provided for. As an example, the General Electric Co. has also identified market position, productivity, product leaderships, personnel development, employee attitudes, and public responsibility as key areas of proper management concern.

Simultaneously with this tendency to broaden the scope of formal management concern, events have complicated the traditional subjects of planning. For example, in addition to building or buying equipment, management now should logically explore the possibility of leasing. As another example, before any major plan can be established, the effect on the tax picture must be very carefully analyzed. In short, at a time when the need for good planning appears to be more critical, the requirements of planning have become more complex.

Despite the successes that have been obtained in the past, it is apparent that in the future a more formal approach to planning will be required in all industries. Where management has identified a specific problem, establishing plans to solve that problem becomes scientific in nature. The emphasis is on identifying, collecting, and manipulating pertinent data in order to obtain some sort of quantitative answers that allow alternative solutions to be evaluated.

The responsibility for handling this type of problem is most generally today split among market research, accounting, industrial engineering, and special administrative staff groups. In addition to the usual mathematical techniques employed, significant progress is being made in the development of more sophisticated techniques—many as a result of the data handling ability of computers.

These newer techniques are generally grouped under the heading of the often misunderstood subject of operations research. To some extent the misunderstanding is a testimony to the usefulness of what operations research stands for. It appears that there is more than a little maneuvering by existing functional groups and their respective technical societies for the honor of being responsible for systems analyses and the application of the newer techniques.

A list of the analytic techniques discussed in operations research literature includes such subjects as: Decision and value theory, organization theory, game theory, inventory theory, statistical theory, probability theory, linear programming, queuing theory, sequencing theory, and replacement theory. Still another important area is that of simulation. Considering the expense of obtaining some experimental solutions and the complexity that bars analytical solutions to many industrial problems, simulation will undoubtedly increase in importance. Of particular significance, a number of companies, including General Electric Co. and Hughes Aircraft Co., have described the successful application of simulation techniques to job-shop activities. With simulation, management is afforded the opportunity to investigate a variety of proposed plans ahead of time and to choose that one which appears most feasible. It should also be noted that simulation underlies many training techniques, including management training games and methods for training operators to oversee complex machine systems.

Although major equipment items, such as computers, are not always required, it is true that both analog and digital computers are often used and sometimes must be used when operations research techniques are employed. This leads to the observation that whoever is made responsible for systems analyses (and sooner or later for most companies someone must be given responsibility), should have a blending of practical experience, advanced mathematical skills, and, ideally, knowledge of computer techniques.

That computers are assuming roles of general importance in the planning domain is also evidenced by some of the modern services offered by computer manufacturers. For example RCA's Electronic Data Processing Div. offers, as a package, a sales forecasting technique utilizing a mathematical model. The technique was originally developed for their own use. As another example, IBM offers a capital investment program suitable for the IBM 1620 Data Processing System. The program permits a variety of capital investment models to be represented, including: Equipment replacement, facilities expansion, acquisitions and mergers, lease vs. purchase, produce or buy, and research expenditures. For use on the GE 225 computer, the General Electric Co. offers a CPM (Critical Path Method) program applicable for optimum project planning, scheduling, and control. The program is suitable for all types of planning including manufacturing projects—an area in which the company itself uses the program.

▶ Control Domain

The control domain embraces all efforts that are made to actively channel forces and materials toward desired end results. Data is an important element of administrative control because it permits communications as to what is wanted and as to progress in obtaining what is wanted. Two important points stand out: Management must decide and present well defined objectives within the capabilities of those ordered to do something; and all concerned levels of responsibility must be able to observe progress toward the objective.

The first point is concerned with the most impor-

tant phase of control. It is apparent that no better opportunity for control exists than at the time when there is a freedom to do or not to do something, and a choice as to the way something is to be done. After an objective has been established, a major problem in control is to determine what effect, if any, current and foreseeable events have on the definition of the objective. Constant review is critical because the original definition of an objective typically involves things outside the control of the organization.

As to the second point, the level of interest of various managers in the progress of efforts relative to a desirable objective can range in scale from "mere curiosity" to "need-to-know." It is important to identify those that need to know, and to satisfy their particular requirements. Identification can be made by a simple test: Who will be held accountable if things do not proceed as planned? A corollary to identifying the need-to-know levels is that progress must be reported within time limits that permit corrective action to be taken commensurate with the level of responsibility.

This latter consideration means that if acceptable control is to be obtained, the elapsed time between reports must be shorter than the incremental time periods for which an authority is nominally responsible. Thus, if a supervisor is responsible for daily progress, he should be able to draw upon hourly or, in some cases, minute-by-minute accounts of efforts. By following the rate of progress as it unfolds, troublesome situations can be quickly identified while the possibility exists that corrective action can be taken.

If the main purpose of reporting is to identify areas where attention is needed, a logical procedure is to apply the rule that "no news is good news," and to selectively report only on situations that require attention. At lower levels of responsibility, this management by exception technique is somewhat of a minor refinement since to determine what isn't progressing as planned it is necessary to keep track of the progress of all planned efforts. At higher levels of responsibility, management by exception can be a real timesaver, enabling a manager to quickly grasp the essence of conditions somewhat removed from his immediate influence.

One other point should be noted. Despite the wealth of information that can be expressed by the tabulation of data, such written or printed data is not easily comprehended by humans. The use of graphic displays and other techniques for pictorializing important information and relationships contained in masses of data are major refinements. Any tool must be designed with the potential user's inherent limitations in mind. The tool, "data," is no exception.

Levels of Control

These various considerations are reflected in the equipment and techniques developed and being developed for the control domain. To aid operators

MAJOR EQUIPMENT ITEMS USED IN DATA PROCESSING

(Code letters are keyed to list entitled Data Equipment Manufacturers)

COMPUTERS

Small scale digital computers—A6 A14, B1 B5 B7, C6 C10 C15, D5, F5, G5, H2, I2 I3 I5, M7, N1, P1, R1 R5 R8, S3, V2

Medium scale digital computers—A6 A14, B1 B5 B7, C10, D5, F5, G2 G5, I3 I5 I9, L3, M3, N1, P2, R1 R5, T6

Large scale digital computers—A6 A14, B7, C15, D5, F5, G5, I3 I5 I9, M3, N1, P2, R5, T3

Punched card computers—A14, D5, G2, I5, R5

Special purpose digital computers—A5 A6 A14, B1 B7, C10, D5, E5, F5, G1 G2 G3 G4 G5, I1 I3 I5 I9, N1 N2 N5, P2, R1 R5, T3

Analog computers—A6, B1 B3, C11, D5, E3 E6, F7, G2 G4 G5, L3, M4, W3

Hybrid analog-digital computers—A3, C11 C13, D5, F7, G2 G4 G5

SPECIAL SYSTEMS

Logging/monitoring—A3 A6 A14, B1, C10 C11 C13, D4 D5 D9, E2 E4 E9, F7 F8, G1 G2 G3 G4 G5 G6, I3 I5 I9, L3, M4, N4 N5, P1 P4, R1 R2 R5, T3 T6, W3

Data reduction—A3 A6 A14, B1, C10 C11 C13, D4 D5, E2, G3, I3 I5 I6 I9, M4 M6, N4, P1, R1 R5, S3 S6, T3 T6

Sorting—A3 A4 A6 A7, B7, C10 C17, F5, G1 G6, I5 I6 I9, N1 N2, P1, R5, S7, T3

Filing—A2 A4, B2, C10, F6, I5 I6 I9, M1, R5, T3

Inventory control—A2 A7, B7, C10, D6, F5 F8, G2 G5 G6, I2 I3 I5 I9, N2, R5, S6, T3

Information retrieval—A6 A7, B6 B7, C10, D6, E1, F5 F6 F8, G1 G2 G6, I2 I3 I5 I6 I9, L1, M1, P1, R3 R5, S6, T3

Shop recording—C15, F8, G2 G6, H1, I5, S6

Data processing to customer specifications—A5 A6, G2, I5, P2, R5

TRANSMISSION EQUIPMENT

Digital data transmission—A1 A8, B1, C7 C14 C15, D4 D5 D8, E5, F7 F8, G1, I2 I3 I5 I9 I10, N2 N5, P2, R1 R5, S3 S8, T3 T4, V2

Written data transmission—A8, C9, C14, F8, I9, S3 S6, T2

Facsimile transmission—A8, D7, F2, G1, I9, S7, W4

Closed circuit television—A8 A11, P2

Pneumatic tube systems—I9, L2, S4

Paperwork conveyors—F8, I9, L2, M2, N2, S4, W4

Transmission system—C7, W2

DATA INPUT DEVICES

Dial-type digital—B1, C17, D5 D6, F1 F8, G1 G6, I5 I9 I10, N5, R5, T3

Key-type digital—B1 B7, C6 C17, D5, E2, F1, G1 G6, I2 I5 I9 I10, M7, N1 N5, R5, S2 S3, T3, V2

Optical character sensors—A4 A7, C17, F4, G2 G5, I3 I9, N2, P1, T3

Magnetic character sensors—A4, B7, C17, G2 G5, N1 N2

Direct sensing physical digital—B7, C1 C13 C17, D4, G2 G6, I3

Combination dial/card/key/etc.—C15, G2 G6

DATA OUTPUT DEVICES

Digital displays—B1 B3 B7, D4 D5, E2, F1 F5, G1 G4, I2 I3 I5 I8 I9, L4, N4, R5, T3, W3

Optical displays—A5 A7, B1 B7, E1, G1 G2, I1 I5 I10, L1

Logging typewriters—B1, C15, D4 D5, F1 F8, G2 G6, I3 I5 I9, M7, R5, S3

Line printers—A4 A10, B1 B7, C6 C15, D4 D5, G1 G2, I5 I10, M7, N1 N2, P5, R5 R8, S3, V2

Graphic recording—B1 B4 B6, C2 C11, E3 E8, F8, G1 G4 G8, I9, K1, L3, W1 W4

immediately responsible for the operation of equipment, a variety of devices can be employed. Noteworthy are audible alarms, visual alarm lights, displays and counters of all types, and readily accessible communication equipment. Where the performance of multiequipment arrangements is being controlled, such techniques as centralized grouping of recorders and graphic display panels in addition to the previously listed devices, are used.

At some point the control problem of supervision of performance arises. Here supervision is to be understood as essentially those activities in which the planning and control domains begin to blend together. In the best of planned activities, interpretation of plans will be required and adjustments made to plans because of contingencies. This phase of control is always required on the production floor and it may also involve remote locations responsible for preparing current operating schedules. One fact is paramount: A high average quality of decisions must be rendered at this level of responsibility if any value is to be obtained from advanced planning efforts.

Because data can be readily transmitted, the supervisory level of control responsibility can make use of centralized groupings of recorders and displays that duplicate the picture presented to operators. But this is not always feasible. Within the past several years, equipment manufacturers have developed special data collection and transmission equipment particularly useful for this level of control. The equipment is designed to simplify and improve the accuracy of reporting of activities and transactions by individual operators.

It will be recalled that in the discussion of the service domain mention was made of the technique of distributing prerecorded order data to production facilities to serve as a basis for later reporting. The shop reporting equipment is generally designed to "read" this prerecorded order data and perhaps, other fixed data on punched or embossed media pertaining to a specific operator. In addition, variable data such as quantity of acceptable production and production time can be fed into the equipment by means of dials, for example. The total result is a complete production report that can be transmitted to a receiving facility or captured in a memory for later machine transcription into a report.

There can be an important difference of emphasis placed on the use of such shop reporting equipment. Because some of the data generated in production facilities falls into the natural data category, the equipment can be thought of as a link in the processing facilities of the service domain. In such uses, the data might flow to a central facility where it would be used, along with other data, to generate a variety of optional after-the-fact information, only part of which would be useful to immediate control of production operations. On the other hand, the production data can be considered as of primary importance to the control-domain. In such uses, the data would be organized to first satisfy the requirements for immediate control and adjustment to current production plans. The use of the data in the service domain would be a secondary consideration. It would appear to be only logical to establish the desired emphasis such that upper management does not reserve for itself equipment

Signal printer—C4 C6, S2 S5
Page printers—G6

EXTERNAL MEMORY EQUIPMENT

Drum memory units—A7 A14, B1 B7, C12 C14, D5, F4 F5, G5, I5 I8 I10, L1 L4, N2, R5, T3
Disk memory units—A7 A14, G2 G5, I3 I5 I8, L1, S3, T3 T5
Tape memory units—A9 A14, B1 B7, C14 C15, D5, G1 G2, I5, P5, R5 R8, T3, W4
Core memory units—D5, R6
Magnetic card memory units—N1

PUNCHED TAPE EQUIPMENT

Tape perforators—A14, B1 B7, C6, D5, E2, F8, G1 G2 G6, I5 I9 I10, M7, N1, R5 R8, S2 S3, T1 T4, U1, V2
Tape readers—A14, B1 B7, C3 C6 C15 C16 C17, D1 D5 D8, E5, F5 F8, G1 G2 G6, I3 I5 I7 I8 I9 I10, N1, P3, R5 R7 R8, S2 S3 S9, T1 T4, W4
Tape reader/perforators—A14, B1 B7, C3 C6, D5, F8, G2 G6, I3 I5, R5 R8, S3, T4
Tape-to-card converters—C10, D2 D5, G1, I5, R5, S8, T1, U1
Tape verifiers—B7, C3, E5, F8, I5 I8 I10, S2 S8, T1
Code converters—F8, T1
Tape handling components—A2, B7, C3, D8, E2 E5, F8, G1 G6, I3 I9 I10, R5, S2, T4
Tape—N3

PUNCHED CARD EQUIPMENT

Card punches—B7, E2, F8, G2, I5, N2, R5, S2, V1
Card readers—B7, D1, G7, H3, I3 I5 I8, N1, R5 R8, S9, U2
Card reproducers—F8, I5, R5, S2
Card typing/calculators—F8, I5, M7
Card-to-tape converters—C10, D4, G1, I5, R5, S8, T1, U2
Card verifiers—C3, I5, R5
Special cards, magnetic strip—B7
Tag punches—D6
Punched tag readers—D6, N1
Tag-to-card converters—C3, D6, I5, R5, S8
Card reconditioners—C17

MAGNETIC TAPE EQUIPMENT

Tape recorders—A9 A14, B7, C8 C15 C16, D7, E2 E7, G1 G2, I4 I5 I9, M4, N1, P5, R5, S1, T6, W4
Tape readers—A9 A14, B7, C16, G2, I5, N1, P5, R5, S1, T6, W4
Tape converters—A13, B4 B7, C10, D8, G1, I5, R5
Magnetic tape—A12, M5, R4

EMBOSSED DATA EQUIPMENT

Plate embossers—A4, D1, F3, S6
Embossed plate readers—A4, D1
Embossed plate printers—A4, D1, F3, N2, S6
Converters—A4, D3

MICROFILM EQUIPMENT

Preparation units—B7, R3, R5
Readers—B7, R3 R5
Automatic copy preparation—B7, G1, M1, R3 R5, X1

PAPERWORK FORMS

Unit forms—B7, C5, M8, N1, S6
Continuous Forms—B7, C5, M8, N1, S6
Forms including optically sensed data—M8, S6
Forms including punched sensed data—A2, D6, M8, S6
Forms including magnetically sensed data—B7, C5, M8, N1, S6

and techniques for checking performance that are superior to those allowed for obtaining performance.

Management of performance might be thought of as the highest level of control. Typically what is being "controlled" is the general direction of an organization's activities. This is merely another way of restating one of management's obligations: The need to continually review plans in the light of current accomplishments and foreseeable circumstances. Obtaining and visualizing relationships of the current data is a major problem in management of performance. Except where poor organization results in undigestible masses of data, computer prepared studies become a management control aid. Still a newer technique being used in industry is a direct offshoot of military practices where a great deal of attention is given to visual displays designed to suggest relationships. The effect might appear to be theatrical to some but real value is reported for central locations where important management data is displayed in model, numerical, or graphic form.

▶ Real-Time Systems

Throughout this discussion we have been concerned with administrative data processing as contrasted with scientific data processing or process control data processing. It is not that the latter two categories are unimportant or even that they cannot be related to administrative data processing. Just the opposite is true. In that some administrative requirements (in the planning domain, for example) are essentially scientific problems, the relationship between administrative and scientific data processing is apparent.

The relationship of administrative data processing and process control data processing is based upon a common interest in some of the natural data of a system. Effective process control requires an almost continuous and instantaneous flow of data from something being controlled to a decision maker. The decision maker must possess the capability of

DATA EQUIPMENT MANUFACTURERS

A1 ACF Electronics Div., ACF Industries Inc., Riverdale, Md.
A2 Acme Visible Records Inc., Crozet, Va.
A3 Adage Inc., 292 Main St., Cambridge, Mass.
A4 Addressograph - Multigraph Corp., 1251 Babbitt Rd., Cleveland, Ohio
A5 Aeronutronic Div., Ford Motor Co., Newport Beach, Calif.
A6 Airborne Instruments Laboratory, Comok Rd., Deer Park, N. Y.
A7 American Systems Inc., 1625 E. 126th St., Hawthorne, Calif.
A9 American Telephone & Telegraph Co., 195 Broadway, New York 7, N. Y.
A9 Ampex Corp., 934 Charter St., Redwood City, Calif.
A10 Anelex Corp., 150 Causeway St., Boston 14, Mass.
A11 Argus Cameras Inc., Argus A-V Systems Dept., Ann Arbor, Mich.
A12 Audio Devices Inc., 444 Madison Ave., New York 22, N. Y.
A13 Auerbach Electronics Corp., 1634 Arch St., Philadelphia 3, Pa.
A14 Autonetics-Industrial Products Div., North American Aviation Inc., 3400 E. 70th St., Long Beach 5, Calif.

B1 Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio
B2 Barry Wright Corp., Wright Line Div., 160 Gold Star Blvd., Worcester 6, Mass.
B3 Beckman Instruments Inc., Berkeley Div., 2200 Wright Ave., Richmond, Calif.
B4 Beckman Instruments Inc., Systems Div., 325 N. Muller Ave., Anaheim, Calif.
B5 Bendix-Computer Div., Bendix Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.
B6 Brush Instruments, E. 37th & Perkins, Cleveland 14, Ohio
B7 Burroughs Corp., Equipment & Systems Marketing Div., 6071 2nd Ave., Detroit 32, Mich.

C1 Calculagraph Co., Box 72, Hanover, N. J.
C2 California Computer Products Inc., 8714 Cleta St., Downey, Calif.
C3 California Technical Industries, 1421 Old Country Rd., Belmont, Calif.
C4 Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati 14, Ohio
C5 Clarkson Press Inc., 189 Van Rensselaer St., Buffalo 10, N. Y.
C6 Clary Corp., 408 Junipero St., San Gabriel, Calif.
C7 Collins Radio Co., Communication & Data Systems Div., P. O. Box 1891, Dallas 21, Tex.
C8 Communications & Control Corp., 14707 Keswick St., Van Nuys, Calif.
C9 Comptometer Corp., Electrowriter Sales Div., 5600 Jarvis Ave., Chicago 48, Ill.
C10 Computer Control Co. Inc., 983 Concord St., Framingham, Mass.
C11 Computer Systems Inc., Culver Rd., Monmouth Junction, N. J.
C12 Consolidated Controls Corp., Bethel, Conn.
C13 Consolidated Systems Corp., 1500 S. Shamrock Ave., Monrovia, Calif.
C14 Continental Technical Service, 19 W. 4th St., Dayton 2, Ohio
C15 Control Data Corp., Computer Div., 501 Park Ave., Minneapolis 15, Minn.
C16 Cook Electric Co., Data-Stor Div., 8100 Monticello, Skokie, Ill.
C17 Cummins-Chicago Corp., 4740 N. Ravenswood, Chicago 40, Ill.

D1 Dashew Business Machines Inc., 3655 Lenawee Ave., Los Angeles 16, Calif.
D2 Data Instruments Div., Telecomputing Corp., North Hollywood, Calif.
D3 Datanamics Inc., 7400 Deering Ave., Canoga Park, Calif.
D4 Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.
D5 Daystrom Inc., Control Systems Div., Miramar Rd., La Jolla, Calif.
D6 Dennison Mfg. Co., Ford Ave., Framingham, Mass.
D7 Dictaphone Corp., 730 3rd Ave., New York, N. Y.
D8 Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y.
D9 Dynapar Corp., 7312 N. Ridgeway Ave., Skokie, Ill.

E1 Electrada Corp., Beverly Hills, Calif.
E2 Electro Instruments Inc., 8611 Balboa Ave., San Diego 11, Calif.
E3 Electronic Associates Inc., Long Branch, N. J.
E4 Electronic Controls Inc., Magee Ave., Stamford, Conn.
E5 Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif.
E6 Embree Electronics Corp., 993 Farmington Ave., West Hartford 7, Conn.
E7 Epsco Inc., 275 Massachusetts Ave., Cambridge, Mass.
E8 Esterline Angus Instrument Co. Inc., P. O. Box 596, Indianapolis 6, Ind.
E9 Executone Inc., 415 Lexington Ave., New York 17, N. Y.

F1 Fairbanks, Morse & Co., 100 Electra Lane, Yonkers, N. Y.
F2 Fairchild Camera & Instrument Corp., Industrial Products Div., 580 Midland Ave., Yonkers, N. Y.
F3 Farrington Business Machines Corp., Subsidiary, Farrington Mfg. Co., Needham Heights 94, Mass.
F4 Farrington Electronics Inc., Subsidiary, Farrington Mfg. Co., 7019 Edsall Rd., Alexandria, Va.
F5 Ferranti Electric Inc., Industrial Park #1, Plainview, N. Y.
F6 FMA Inc., 142 Nevada St., El Segundo, Calif.
F7 Foxboro Co., Neponset Ave., Foxboro, Mass.
F8 Friden Inc., 2350 Washington Ave., San Leandro, Calif.

G1 General Dynamics/Electronics, 100 Carlson Rd., Rochester 3, N. Y.
G2 General Electric Co., Computer Dept., 13420 Black Canyon Highway, North, Phoenix, Ariz.
G3 General Electric Co., Process Control Section, 13420 Black Canyon Highway, North, Phoenix, Ariz.
G4 General Precision Inc., Link Div., Binghamton, N. Y.
G5 General Precision Inc., Librascope Div., 808 Western Ave., Glendale, Calif.
G6 General Time Corp., Stromberg Div., Thomaston, Conn.
G7 Genesys, Los Angeles 34, Calif.
G8 Gerber Scientific Instrument Co., Hartford, Conn.

interpreting the significance of the data and making adjustments in controllable variables of the process so as to obtain some desired end result. It is apparent that some of the data (time, composition, quantity, quality, etc.) might also be of use in several of the administrative domains.

The successful application of computers as the decision makers in establishing closed-looped process systems has paralleled increasing use of computers in administrative roles. The capability of modern equipment and sophistication of modern techniques are such that advanced thinkers can visualize a more comprehensive closed control loop that includes tasks presently considered as administrative—with the result that an automatic, computer controlled plant can be obtained.

A more generally meaningful picture of tomorrow is created by those that stress the benefits of "real-time" administrative systems. It is visualized that when the capabilities of computers are supported by advanced data transmission techniques, data systems can be created in which all pertinent information, in the required form, is immediately available to responsible levels in an organization. The concept is a logical extension of the philosophy underlying present developments in methods and data equipment in both user and seller industries.

For example, real-time systems will depend upon the ability of machines to "talk" to machines—not only within a building but also between remote locations. This ability is possessed by the source reporting equipment described in the discussion of the control domain. Indeed, it is an attribute of various types of equipment based upon punched cards, punched tape, magnetic tape, and embossed media that the information on such media can be automatically transmitted by wire or microwave techniques and rerecorded at the receiving facility. This means that the receiving facility has data immediately available in a form capable of being processed in a variety of ways by machines. Commenting on this phase of data handling, F. R. Kappel, president of American Telephone and Telegraph Co., has said, "We have a strong feeling that in a

H1 Hancock Industries, Telecontrol Div., Jackson, Mich.
H2 Harvey-Wells Electronics Inc., 14 Huron Drive, Natick, Mass.
H3 Hickok Electrical Instrument Co., Cleveland, Ohio

I1 Industrial Electronic Engineers Inc., North Hollywood, Calif.
I2 Information Products Corp., 156 6th St., Cambridge, Mass.
I3 Information Systems Inc., 10131 National Blvd., Los Angeles 34, Calif.
I4 Infotronics Corp., 1401 S. Post Oak Rd., Houston 27, Tex.
I5 International Business Machines Corp., 112 E. Post Rd., White Plains, N. Y.
I6 International Electric Corp., Associate of ITT, Route 17, Paramus, N. J.
I7 Invac Corp., 14 Huron Drive, Natick, Mass.
I8 ISI Inc., Computer Products, 10131 National Blvd., Los Angeles 34, Calif.
I9 ITT-Intelex Systems Div., 67 Broad St., New York 4, N. Y.
I10 ITT-Kellogg, 6650 S. Cicero Ave., Chicago, Ill.

K1 Kelnath Instrument Co., Columbus, Ohio

L1 Laboratory for Electronics Inc., 1079 Commonwealth Ave., Boston, Mass.
L2 Lamson Corp., Lamson St., Syracuse, N. Y.
L3 Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.
L4 Litton Systems Inc., Computer Systems Laboratory, 5500 Canoga Ave., Woodland Hills, Calif.

M1 Magnavox Co., Fort Wayne, Ind.
M2 Mercury Industries Inc., Hillsdale, N. J.
M3 Minneapolis-Honeywell Regulator Co., Electronic Data Processing Div., 60 Walnut St., Wellsley Hills 81, Mass.
M4 Minneapolis-Honeywell Regulator Co., Industrial Products Group, Wayne & Windrim Ave., Philadelphia 44, Pa.
M5 Minnesota Mining & Mfg. Co., Magnetic Products Div., 900 Bush Ave., St. Paul 6, Minn.
M6 Monitor Systems Inc., Subsidiary, Epsco Inc., Fort Washington Industrial Park, Fort Washington, Pa.
M7 Monroe Calculating Machine Co. Inc., Div., Litton Industries, 60 Main St., San Francisco, Calif.
M8 Moore Business Forms Inc., 900 Buffalo St., Niagara Falls, N. Y.

N1 National Cash Register Co., Dayton, Ohio
N2 National Data Processing Corp., Ross at Prairie Ave., Dallas, Tex.
N3 National Vulcanized Fibre Co., Wilmington, Del.
N4 Non-Linear Systems Inc., Box 728, Del Mar, Calif.
N5 North Electric Co., 501 S. Market St., Galion, Ohio

P1 Packard Bell Computer Div., 1905 Armacost Ave., Los Angeles 25, Calif.
P2 Philco Corp., Government & Industrial Group, Computer Div., 3900 Welsh Rd., Willow Grove, Pa.
P3 Photocircuits Corp., Glen Cove, N. Y.
P4 Post Electronic Products, 12 Lothrop St., Beverly, Mass.
P5 Potter Instrument Co., Sunnyside Blvd., Plainview, L. I., N. Y.

R1 Radio Corp. of America, Electronic Data Processing Div., Industrial Computer Systems Dept., 21 Strathmore Rd., Natick, Mass.
R2 Radio Corp. of America, Industrial & Automation Div., Front & Cooper St., Camden 2, N. J.
R3 Recordak, Subsidiary, Eastman Kodak Co., 415 Madison Ave., New York 17, N. Y.
R4 Reeves Soundcraft Corp., Great Pasture Rd., Danbury, Conn.
R5 Remington Rand, Div., Sperry Rand Corp., 315 4th Ave., New York 10, N. Y.
R6 Rese Engineering Inc., Philadelphia 6, Pa.
R7 Rheem Mfg. Co., Electronics Div., 5200 W. 104th St., Los Angeles, Calif.
R8 Royal McBee Inc., Data Processing Div., Westchester Ave., Port Chester, N. Y.

S1 Shepherd Industries Inc., Nutley, N. J.
S2 Soroban Engineering Inc., P. O. Box 1717, Melbourne, Fla.
S3 Smith-Corona-Marchant Inc., 410 Park Ave., New York 22, N. Y.
S4 Standard Conveyor Co., North St. Paul 9, Minn.
S5 Standard Instrument Corp., 657 Broadway, New York 12, N. Y.
S6 Standard Register Co., Dayton 1, Ohio
S7 Steward-Warner Corp., Electronics Div., 1300 N. Kostner Ave., Chicago, Ill.
S8 Systematics, Div., General Corp., 3216 W. El Segundo Blvd., Hawthorne, Calif.
S9 Systronics, Torrance, Calif.

T1 Tally Register Corp., 1310 Mercer St., Seattle 9, Wash.
T2 TELautograph Corp., 8700 Bellanca Ave., Los Angeles 45, Calif.
T3 Teleregister Corp., 445 Fairfield Ave., Stamford, Conn.
T4 Teletype Corp., 5555 Touhy Ave., Skokie, Ill.
T5 Telex Inc., Data Systems Div., St. Paul, Minn.
T6 TRW Computers Co., Div., Thompson Ramo Wooldridge Inc., 8433 Fallbrook Ave., Canoga Park, Calif.

U1 Underwood Corp., One Park Ave., New York City, N. Y.
U2 Uptime Corp., Broomfield, Colo.

V1 Varifab Inc., High Falls, N. Y.
V2 Victor Adding Machine, 3900 N. Rockwell St., Chicago 18, Ill.

W1 Wagner Electric Corp., St. Louis, Mo.
W2 Western Union, Private Wire Div., New York, N. Y.
W3 Westinghouse Electric Corp., Pittsburgh 30, Pa.
W4 Westrex Corp., Div., Litton Systems, 6601 Romaine St., Hollywood 38, Calif.

X1 Xerox Corp., Rochester 3, N. Y.

few years' time, data communications will actually exceed, in sheer volume, the communication of speech."

All Can Benefit

Considering the cost of buying or leasing a large computer, the transmission of data from a number of sources to a central computer facility is both feasible and attractive for multidivision or multi-office businesses. With a wide variety of computers to choose from, some businesses have also developed data systems which employ smaller computers for limited purposes in outlying facilities, depending upon communications with a single large computer for extensive problems or data handling tasks.

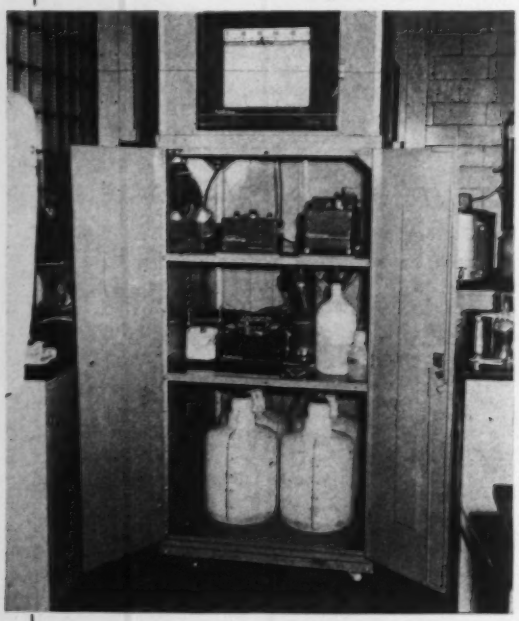
Interest in such techniques is not confined to only the larger companies. With the continuing growth of centers that rent spot time on computers, any business can provide itself with means for sharing in the benefits promised by computer technology.

Significant strides are being made in establishing computer centers. Major equipment manufacturers (International Business Machines Corp., Radio Corp. of America, and National Cash Register Co. are examples) maintain computer centers which provide services for companies not owning computers. There is also evidence to suggest that both universities and banks will become major factors in supplying computer services in the future. Universities are particularly suited to helping industry with scientific type studies; banks are particularly suited to handling financial data and repetitive data transactions. By offering services to a number of industrial users, large scale installations can be maintained for the mutual benefit of many.

However far removed real-time industrial systems are from general use, more and more frequently one hears of the real-time services to be performed by a data system being compared to the type of services offered by a utility. In the manner that water or electricity is made available to users within an organization, it is envisioned that users could draw upon a central source for whatever information is needed to perform a job. Actually, this analogy is useful as well as interesting. For example, it highlights that information, like electricity, has only a potential value until put into use; that it is the quality of data and not its source that is really important; that for many companies, services connected with processing data might be obtained more cheaply outside the company; that information transcends artificial barriers such as organizational structures; and that information can be piped to wherever required in a discriminative manner to serve an operator in the shop or a manager in the front office.

Sooner or later all companies will reach the decision that it would be wise to relate their data handling problems to the capability of modern data handling equipment. For the benefit of readers who desire to make such an investigation now, an equipment and manufacturers' listing is included with this article. The range of equipment offered is suggestive of the variety of solutions which can be obtained by the imaginative manager to suit his exact requirements.

on-stream analysis of silica and phosphate content



CONTINUOUS automatic chemical analysis system is monitoring silica and phosphate content of water in a modern high pressure boiler at Meramec Plant, Union Electric Co. High purity water and the means to check that purity are vital for economic and efficient operation of modern steam systems. For instance, without early warning of a rise in silica content and effective action, silica will produce glossy deposits on turbine blades and reduce turbine efficiency.

In the AutoAnalyzer supplied to Union Electric by Technicon Controls Inc., silica content is detected within fractional parts per million. The analyzer's pump unit proportions samples and reagents in a continuously flowing stream. Peristaltic pumping action is created by compressing plastic tubes against a platen with rollers. The amount of a given fluid that is pumped through the analyzer is governed by the tube size.

A characteristic blue color indicating silica concentration is developed in the analyzer stream. Color intensity is measured in a flow-type colorimeter, and the indication of silica content is plotted continuously on a strip chart recorder.

JOINING COIL STRIP ON A CONTINUOUS LINE

AUTOMATIC coil steel welding and looping system which is smaller, less costly, and faster than similar units of the same capacity now in use has been developed for users and processors of coiled strip steel. Two companies, Guild Metal Joining Equipment Co. and Mechanical Equipment Co., co-operated in the design and production of the six-component system, which promises to reduce strip handling and processing costs. The first system has been installed at a strip mill of Jones & Laughlin Steel Co.

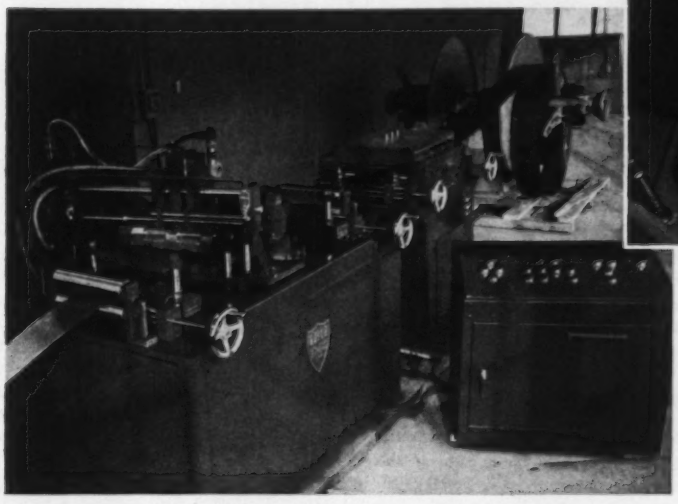
Heart of the system is a high speed shearing and end welding machine which automatically welds the leading edge of a new coil of steel to the trailing edge of an exhausted coil. This operation is accomplished fast enough to eliminate stopping or slowing down of the processing line. The system will handle coiled strip up to 3/16 inch in thickness by 15 inches in width at speeds up to 150 feet per minute.

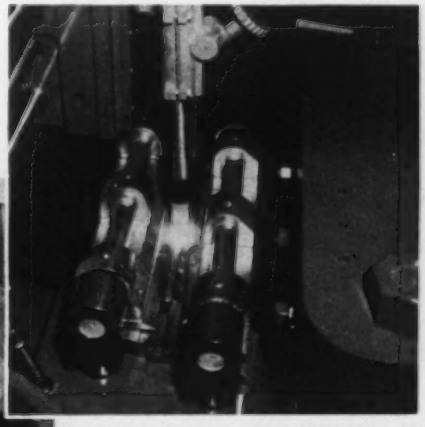
In operation, coils of steel are loaded on a double-end uncoiler by a standing jib crane equipped with a C-hook. The empty side of the uncoiler can be loaded while steel is paying off the full side. As the trailing edge of an exhausted coil leaves the uncoiler and starts through a pinch roll and flattener unit, an ultrasonic detector senses the edge and starts a timing device. After a preset interval, depending on strip speed, the timing device actuates a clamp on an overhead looping mechanism installed between the end welding machine and the strip processing equipment. This action stops the end of the strip within the combination shearing and welding unit and releases the loop carriage. As the carriage rides forward during the shear-weld process, up to 360 feet of strip steel stored in the loop is fed to the processing equipment.

Within the welding unit, another clamp holds the trailing edge of steel as it is trimmed at a 15 degree angle. The leading edge of the new coil is fed through the flattener and into the welder where it is also sheared at an angle. The two edges are then butted against one another as the welding head indexes into position. Welding is accomplished by a tungsten arc process at a rate of 30 inches per minute for most strip thicknesses.

With welding finished, the clamps on the overhead loop and on the welder are released, permitting new strip to flow through the system. A powered winch then returns the carriage to its nomal position, building up the system's 360 feet of strip storage. The entire sequence is automatically controlled once the strip is fed into the welder and an *Entry* button is pressed.

The winch-powered overhead looping unit uses only one metal loop and stores horizontally. The overhead looping mechanism releases valuable floor space for processing equipment. All controls for the looping mechanism are tied into circuits of the end detector and end welder, and no operator is necessary.





Part of the coil steel welding and looping system is shown in this view taken in the builder's plant. In the right background is the double-end uncoiler which feeds strip to the flattener unit, center, and then to the shearing and end welding machine in the left foreground. Inset shows the butt ends of the old and new coils being automatically welded by a tungsten arc process.

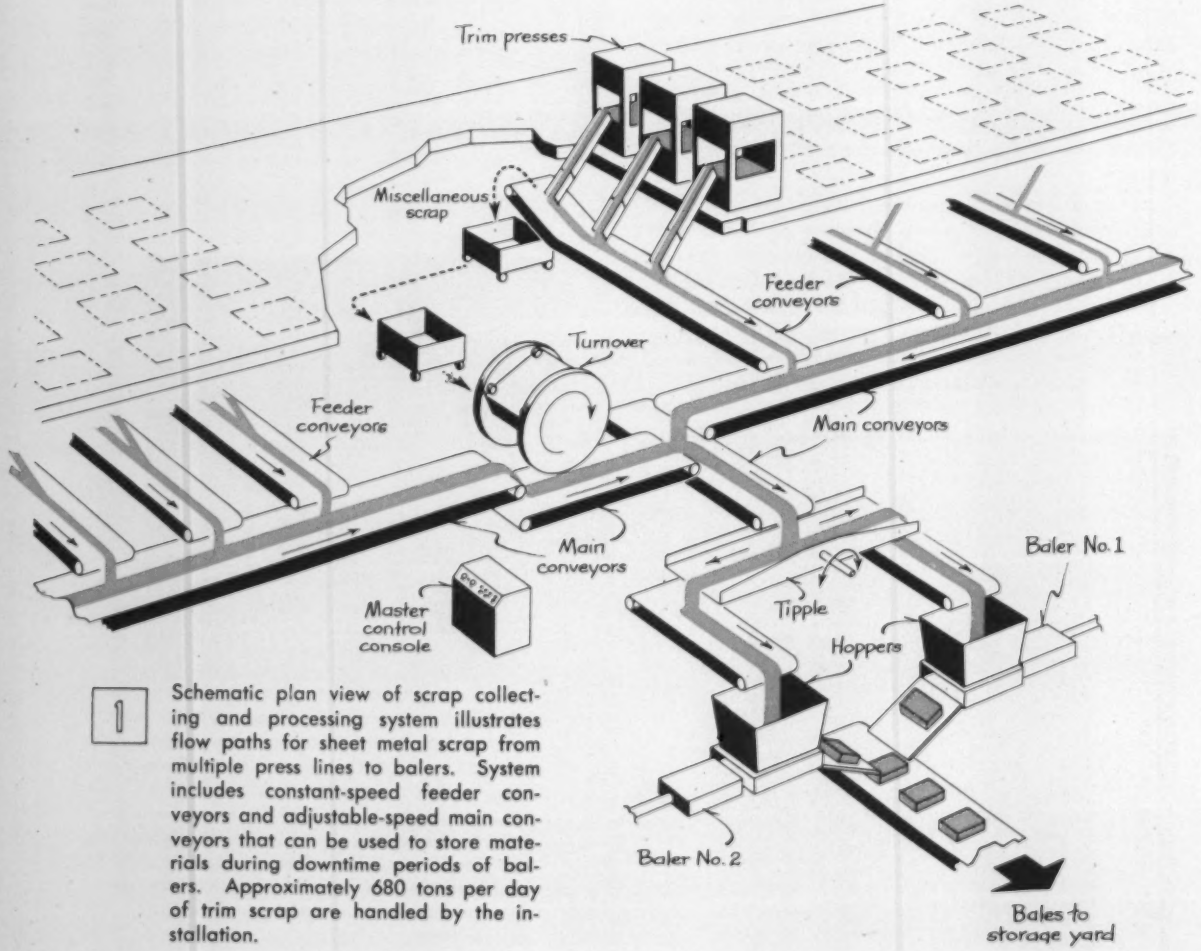
AUTOMATION TODAY

HANDLING AND BALING SCRAP

FROM MULTIPLE PRESS LINES

By G. H. MEYFARTH, Vice President & General Manager, May-Fran Mfg. Co., Cleveland, Ohio

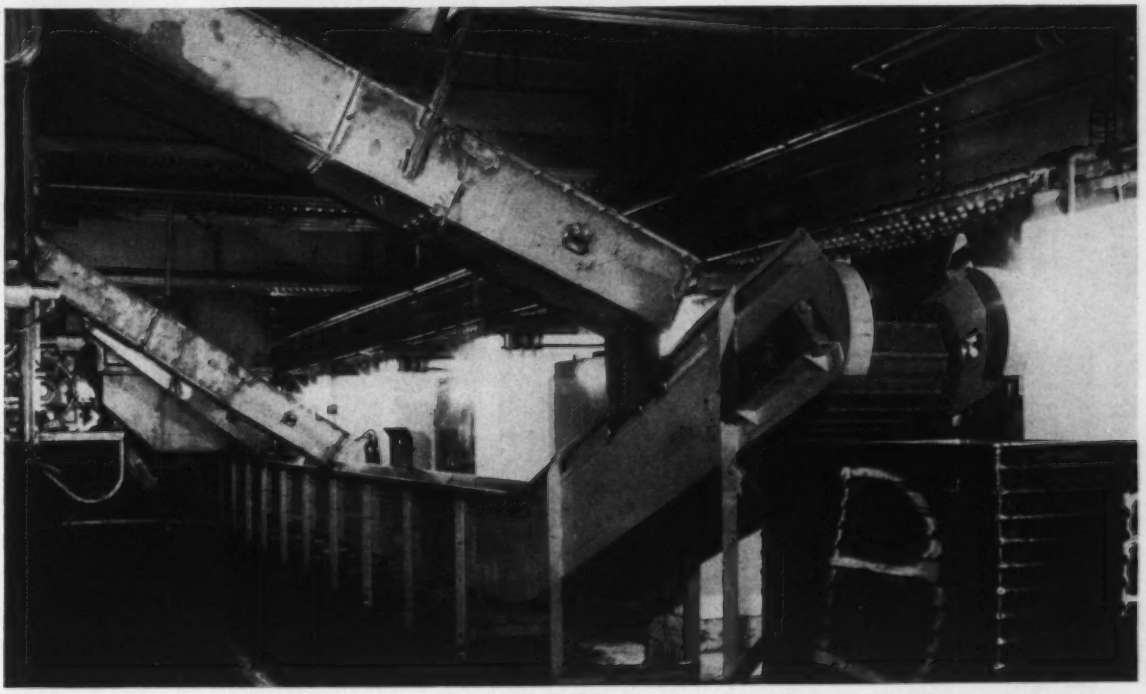
ONE OF THE byproducts of an automobile stamping plant is sheet metal scrap from trim presses. Efficient removal and processing of this material can require a sizable scrap collecting and baling installation. At the Cleveland Stamping Plant of Ford Motor Co., for example, an integrated system that includes 22 constant-speed feeder conveyors, four adjustable-speed main conveyors, and two baler conveyors is used to move 680 tons per day of trim scrap from the presses to the balers. The system includes interlocks and safety devices and incorporates controls for special operating conditions.



1 Schematic plan view of scrap collecting and processing system illustrates flow paths for sheet metal scrap from multiple press lines to balers. System includes constant-speed feeder conveyors and adjustable-speed main conveyors that can be used to store materials during downtime periods of balers. Approximately 680 tons per day of trim scrap are handled by the installation.

2

Trim press in a press line on the main plant floor receives sheet metal parts on the conveyor at right. After trimming, parts are automatically ejected and moved to the next operation. Trim scrap slides down a trough, foreground, and falls into a chute through an opening in the floor in front of the press.

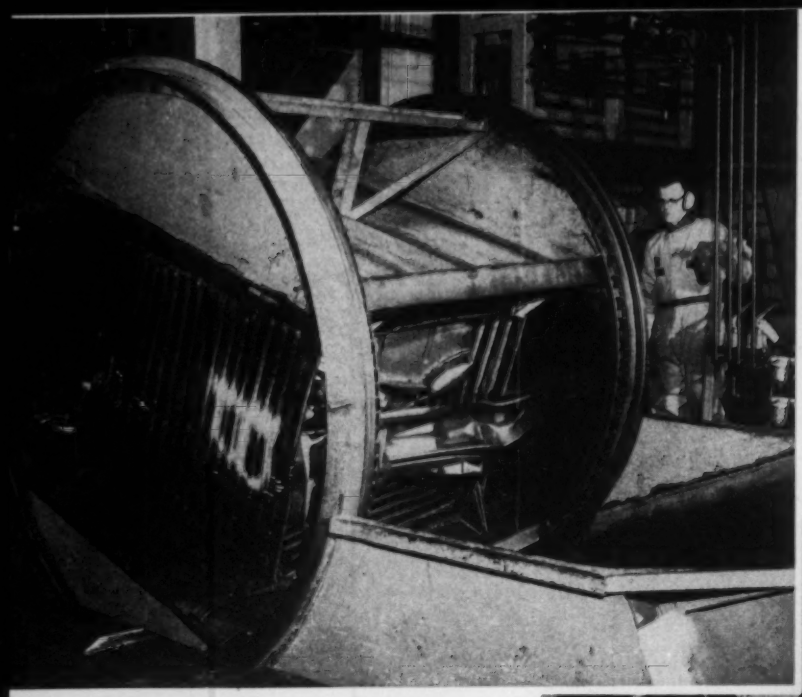


Overhead chutes deliver scrap pieces from each press in a line to the feeder conveyor for that line. Rear end of reversible feeder conveyor is angled upward, right foreground, so that material can be dumped into a scrap bin if the rest of the handling system is shut down. If the feeder conveyor is inoperative, short sections on the ends of the chutes can be removed and replaced with covered, vertical sections that direct scrap pieces into bins placed beneath the chutes. Normally, scrap is moved to the left on the feeder conveyor and dropped onto one of two main conveyors that collect the scrap from all of the feeder conveyors. Conveyor belting supplied by May-Fran Mfg. Co.

3

More than a mile of hinged-steel conveyor belting, supplied by May-Fran Mfg. Co., is used.

Prior to installation of the new system, scrap was directed from presses on the main plant floor, through chutes, and into scrap tubs in the basement. When



4

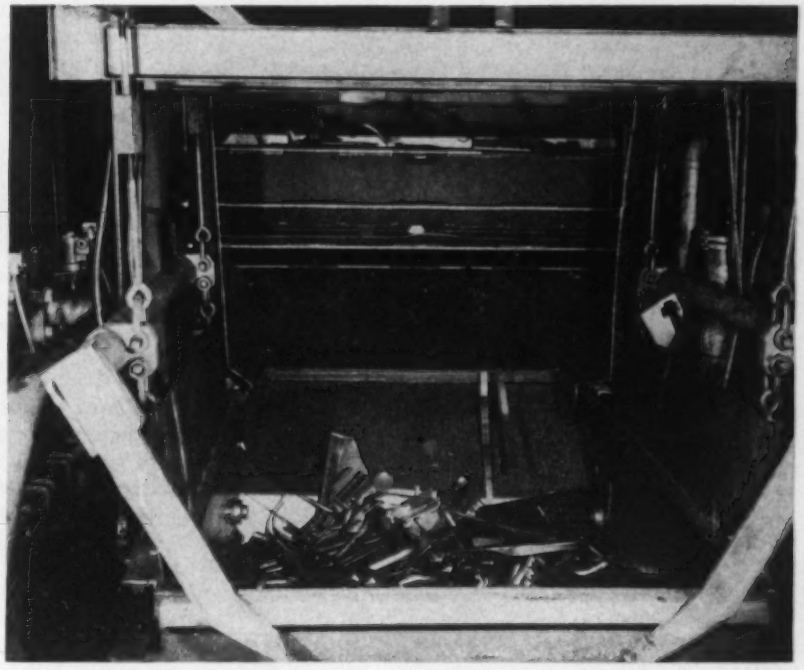
Rejected stampings and trim scrap from small press lines not served by the feeder conveyors can be introduced into the system by means of this turnover. Bins containing such material are placed in the unit and are inverted to dump their contents onto a main conveyor. Material collected in bins beneath the trim press chutes or at the ends of feeder conveyors operating in the reverse direction can also be added at this point.

5

Scrap from the main conveyors that collect material from the feeder conveyors and from the turnover is merged at this point. The combined scrap falls onto the conveyor in the foreground and is brought forward to a tipple.

6

Function of the tipple, center, is to direct scrap delivered on the conveyor, top center, to either of two conveyors leading to the balers. Photo shows the tipple in a position to feed scrap to the baler conveyor in the foreground. The tipple can also assume a horizontal position to block the flow of material or it can tilt in the opposite direction to feed the other baler conveyor. Position of the tipple is automatically controlled to maintain maximum efficiency of baler operations.



7

Material delivered on the two baler conveyors is dropped into hoppers above the balers. When a hopper load of 750 to 900 pounds of scrap has been accumulated, material is released from the hopper and falls into a baler.

filled, the tubs were pulled by industrial tractors to a centralized turnover device where the scrap was emptied onto conveyors leading to the balers. Although adequate, the old scrap removal system had two major disadvantages. First, it was inefficient. Second, the manual handling of sharp pieces of metal scrap, often required with this method, created a safety problem.

The new scrap system had to meet the following specifications:

1. The entire system had to be installed without disturbing the old handling method or interrupting the operation of the press lines.
2. The new system had to be capable of expansion in order to accommodate possible additions to press capacity.
3. Means had to be provided for the continuous removal or storage of scrap if a baler or conveyor breakdown occurred.

In normal operation of the system, scrap from the trim presses falls into chutes leading to the basement. There, the scrap from the chutes for each press line drops onto a common feeder conveyor serving that line. The feeder conveyor then discharges the scrap to one of two main conveyors that accumulate the scrap from all the feeder conveyors.

Scrap collected on these main conveyors eventually merges as it drops onto a main conveyor that carries the combined material to a tipple. Other scrap can be introduced into the system by means of a turnover that empties the contents of scrap bins onto a main conveyor. One source of such scrap is from small press lines not served by the conveyor system.

The tipple operates automatically in relation to the operation of the two balers. It is, in effect, a three-position chute that tilts automatically to feed either of two baler conveyors. The direction of tilt is dependent upon which baler is operating or upon the frequency of baler operations. If the balers are shut down, the tipple automatically assumes a neutral, or horizontal, position.

From each baler conveyor, scrap is dumped into a hopper above a baler. When a hopper is filled with 750 to 900 pounds of scrap, the material is fed to the baler and compressed. Bales are then discharged to a pusher-type conveyor and moved to a storage yard for subsequent loading in railroad cars.

Several provisions have been made to maintain the flow of scrap from the press lines in the event of system malfunctions. For example, if a feeder conveyor is shut down, removable sections at the ends of the chutes leading from the presses can be replaced with covered extensions to direct scrap from the presses into scrap bins on the basement floor. This is, essentially, a return to the old scrap collection method.

If the main conveyors or the balers are stopped, the feeder conveyors can be reversed. With a feeder conveyor operating in the reverse direction, scrap may be received by a bin placed beneath an inclined section at the rear end of the feeder conveyor.

With one baler shut down, an override selector switch may be operated to place the tipple on manual control. In this mode of operation, the tipple can be set to feed all of the scrap to the baler which is operating. In case of emergency, the tipple can be moved to its neutral position.

The conveyor system can also be used to store scrap during downtime periods for both balers. Two emergency procedures are available in this case. In the first procedure, the tipple returns to its neutral position when the balers are stopped. The main

conveyors receiving scrap from the feeder conveyors and the turnover continue to operate for two or three minutes at half speed and then stop. The main conveyor leading to the tipple runs for an additional two or three minutes and stops. After these conveyors have stopped, the feeder conveyors continue to run an additional two minutes.

If the balers have not been restored to operation in this time, a foreman at a master control console can place a selector switch in an *Emergency Run* position. This initiates the second emergency procedure whereby the main conveyors are operated at half speed.

With these two emergency procedures, the system can be used to store scrap for approximately two to three hours. If the balers are to be down for a longer period of time, scrap bins can be placed at the ends of the feeder conveyors, and the conveyors can be reversed.

Since it is not possible for an operator at the master control console to view the entire system, several safety checks had to be installed. For example, the first press in each press line is designated as a control point. On this press there are two indicating lights and a pushbutton station. The lights indicate the operating status of the feeder conveyor beneath the press line, and the pushbutton station serves as an emergency stop control for the conveyor. When this control is actuated, the conveyor stops and an indicator light on the master control console shows the stoppage and location. To restore operation of the feeder conveyor, the pushbutton on the press must be reset manually.

A second control point is located at the drive end of each feeder conveyor. There, lights indicate circuit and operational conditions for the conveyor and controls permit starting, stopping, and reversing of the unit. Two pull cords are located at the sides of each feeder conveyor to permit emergency stopping. Once stopped by a pull cord, a conveyor cannot be restarted until the cord has been reset.

The drive for each feeder conveyor is equipped with a zero-speed switch that signals the occurrence of a conveyor stoppage due to a jam or overload. The switch is mechanically connected to a shaft in the drive, and operates by centrifugal force. If the shaft is not rotating, the zero-speed switch will complete a circuit to operate a fault light on the master control console. When the fault light goes on, an operator at the console stops the conveyor. It cannot be restarted until the fault is corrected and power is fed to the conveyor through a disconnect switch at the drive end control point. Reverse conveyor operation can be initiated only from this point.

The four main conveyors are powered by adjustable speed drives. This feature is necessary so that system operating speed can be preset according to the amount of scrap being generated. It also permits extra running time for storing scrap on the conveyors under emergency operating procedures. Speed indicators and controls on the master console permit monitoring and adjusting the speeds of the conveyors. Range of adjustment for each main conveyor drive is 100 to 1700 rpm.

To put the scrap removal system into operation, the balers and baler scrap conveyors are started first. Then the main conveyors receiving scrap from the feeder conveyors and the turnover are started, followed by the main conveyor leading to the tipple. A series of electrical interlocks prevents starting of the feeder conveyors until the main conveyors have run for approximately two minutes. An emergency control on the master control console will shut off all four main conveyors. The feeder conveyors are stopped individually.

8

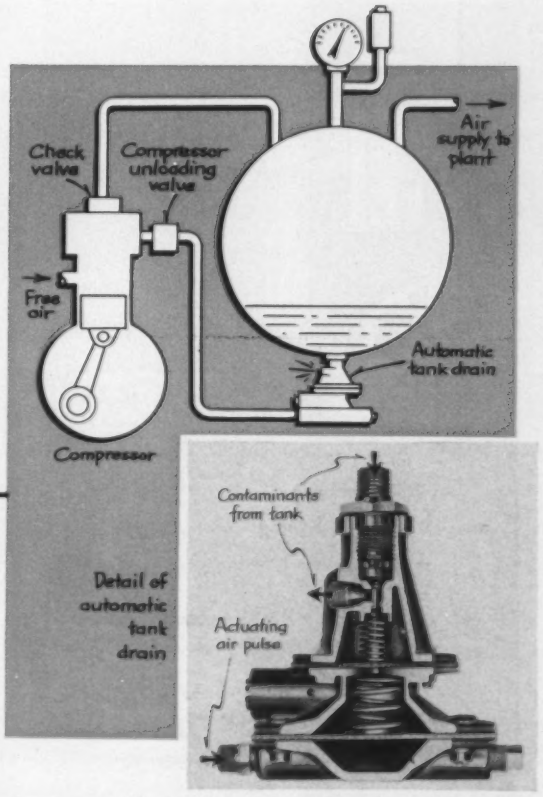
Bale of scrap has been discharged from the baler chute at right. It will next be moved forward to a storage yard when a pusher link, carried by roller chains, contacts the rear of the bale.

Components of compressed air supply systems—compressors, tanks, regulators, filters, and lubricators—are usually designed to require minimum maintenance. But some maintenance is necessary for proper operation. This data sheet records some general maintenance suggestions and comments on installation practices that simplify maintenance of compressed air systems.

AIR SUPPLY MAINTENANCE

By **DON W. BRENNER**
General Sales Manager
Wilkerson Corp.
Englewood, Colo.

COMPRESSED AIR supply systems are basic facilities in nearly all industrial plants. Because of their widespread and long-standing use such systems can incorporate many features that have been developed to provide reliable service with minimum maintenance requirements. However, these very developments can lead to maintenance difficulties if they allow plant operators to forget that some maintenance is necessary.



Compressor and Receiver Tank

Perhaps the most neglected piece of equipment in an industrial plant is the air compressor. Compressor manufacturers have done such a good job in building a rugged, long-lasting piece of machinery that they have caused many plant operators to feel safe in locating compressors in dirty, inaccessible spots.

Actually, the correct location of the compressor is the initial step to its proper maintenance in the future. It should be installed in such a way that the intake will run outside if possible and will not draw in steam, acid fumes, grit, or other contaminants.

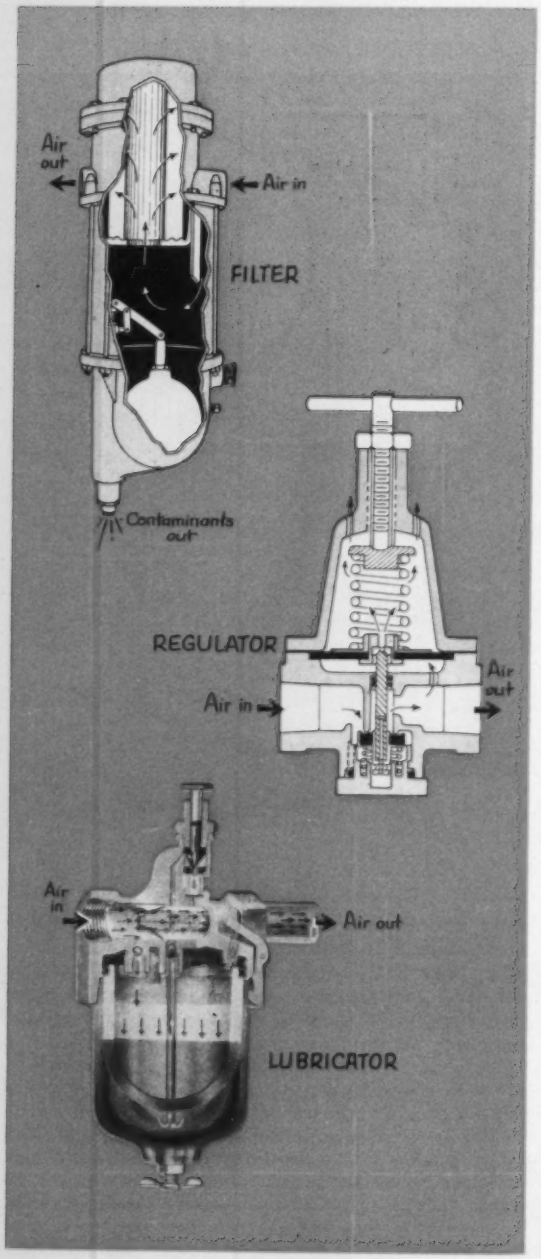
After a compressor and tank have been installed, two things that might be singled out as most important are to keep oil in the compressor and water out of the tank. Lubricant level in the crankcase should be continually checked, and oil should be replaced according to the manufacturer's recommendations. When oil consumption increases excessively, the rings need replacing. This should be done promptly because crankcase oil should not be allowed to enter the compressed air system. It not only creates deposits on compressor valves, but coats the entire compressed air pipe system, gums up air valves, varnishes air cylinder walls, ruins painting operations, and causes other troubles. It may lead, for instance, to an internal tank explosion.

A compressor installation is carefully designed with three major parts in mind—the compressor, the motor, and the tank. Each is sized to the others by design. However, a careful design is unbalanced by letting water build up in the tank. Since water occupies valuable air storage space, the compressor must run more often, wasting power and cutting compressor life. Water in the tank also causes tank corrosion and carries over into the air system.

Tanks can be drained manually, say on a daily schedule, and water and oil buildup can be eliminated. The probability that the schedule will not be regularly maintained can be reduced by use of an automatic tank drain. The unit shown by the cutaway view automatically drains the receiver tank each time the air in the tank reaches its maximum pressure setting. Impulse of air from compressor unloader enters below lower diaphragm and causes rubber valve to be raised from its seat. Air in the tank forces water and other con-

taminants down from bottom of tank through upper connection to tank drain and out exhaust port at upper left.

Other points for compressor maintenance include the following: 1. Check compressor intake filter once a week, clean at least once a month or more often under dirty conditions. 2. Regularly check air gage on tank to see if compressor cuts off at the same pressure as when originally installed. 3. With the compressor not running and the main line valve closed, open the safety valve until the compressor starts up. Close the safety valve and record the length of time required for the tank to build up to shut-off pressure. When this time gets appreciably longer, it is a sign that the valves and/or rings need maintenance. 4. Inspect compressor drive belts regularly and adjust belt tension when necessary. 5. Check compressor unloader regularly; drive motors can be burned out by starting up against full pressure in the compressor head.



Filter

It is not unusual to go through a plant and see air line lubricators empty and air line filters full. This is an obvious sign that a plant does not have proper maintenance of compressed air accessories. A filter full of water is no filter at all. On a manually drained filter regular daily routines must be established to drain the filter sump. Once a month the filter bowl should be cleaned and the filter cartridge removed and cleaned. Washing it in a solvent and blowing it off with air may be all that is required.

Failure to drain the sump, clean the bowl, and clean the cartridge will mean that the filter will be flooded and hence useless, the cartridge will be so loaded with dirt it will choke off the flow of air, and the bowl will become so dirty that the need for draining cannot be observed.

The draining problem can be met by use of an automatic-draining filter such as that shown in the cutaway illustration. Air enters through the port at upper right, passes through the filter and out at upper left. Water and other contaminants collect in the sump and are automatically blown out the port at bottom when the float opens the drain valve.

Regulator

A regulator, or pressure reducing valve, requires little maintenance. Remove the bottom plug once a month and blow off the internal parts. If there is a screen in the plug, clean it off with air also. The sketch illustrates a typical compressed air regulator with a self-relieving feature. Basic operating effects are for the main spring above the diaphragm to open the valve when pressure drops in the outlet port at right. When pressure builds up in the outlet to the preset point, the back pressure on the diaphragm overcomes the spring force and closes the valve.

Lubricator

An air line lubricator must have oil in it to function. Regular daily or weekly filling routines are required, depending upon how much air is used. The schedule for filling lubricators should be timed to the needs of the lubricator on the system which requires filling most often.

If a lubricator has no sight glass by which to tell if it is operating, the oil level can be marked on the bowl and a check made later to see that oil is being used. Only misguided maintenance men say they like a certain lubricator because it doesn't use oil.

The bowl of a lubricator should be cleaned periodically so that visual checks may be made on its operation and oil added when required. Contaminants should be drained off each time the lubricator is filled. Moisture and dirt settle to the bottom of the bowl under the oil. Since this is where the entrance to the siphon tube is located, these contaminants will be picked up before the oil if they are not removed.

Filling of the lubricator should be as easy as possible. The cutaway illustration shows the flow of air and oil as atomizing and mixing take place. This unit also has two fill plugs in large fill holes through which oil can be poured without turning off the air supply.

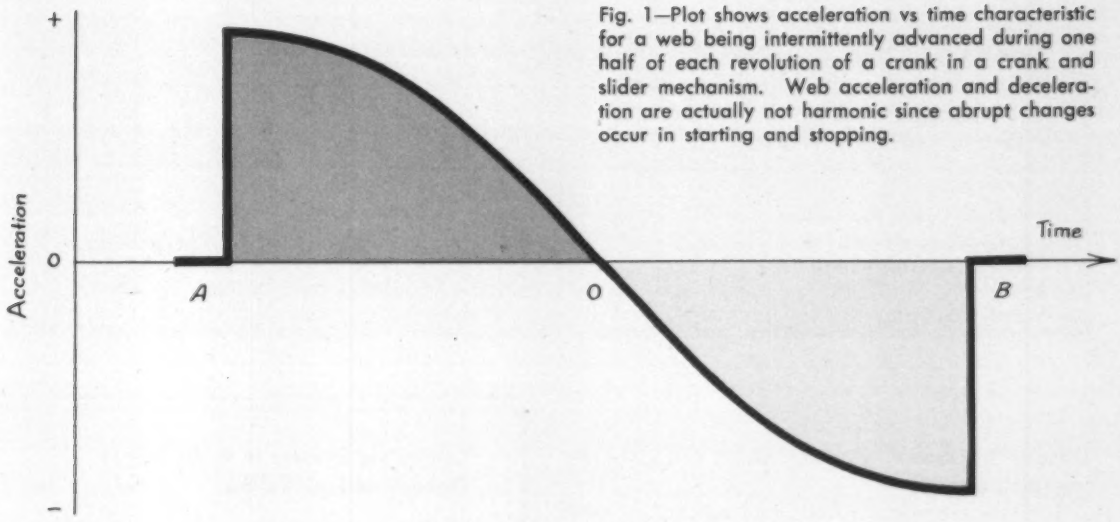


Fig. 1—Plot shows acceleration vs time characteristic for a web being intermittently advanced during one half of each revolution of a crank in a crank and slider mechanism. Web acceleration and deceleration are actually not harmonic since abrupt changes occur in starting and stopping.

INTERMITTENT FEEDING OF METAL WEBS

Many production operations call for the intermittent feeding of materials in the form of a web or strip. One of the people who have faced such problems is our author, who presents comments on three basic types of intermittent feeds. For convenience he presents calculations and experimental data on feeding of metal webs, but points out that similar considerations apply to webs of many other materials.

By **C. N. NEKLUTIN, P. E.**, Consulting Engineer,* St. Louis, Mo.

CONTINUOUS webs are being used to supply more and more production operations, and a great many of those operations are such that the advance of the webs must be intermittent. Most operations performed by reciprocating elements from above, below, or either side of a web require that the web pause while the element cycles. The web must then advance a specified distance and pause again while the element cycles at the succeeding point of the web.

Often the product is such that locating dimensions between the successive points of operation on the web must be held accurately to specifications. This requirement is frequently found where a single machine element repeats its operation at more than one point along the length of the web to produce a single piece of the final product. The requirement of accurate step advances is also important in machines where several elements along the path of the web must perform operations in

*Formerly Vice-President of Engineering, Universal Match Corp.

TABLE 1 · VARIATION OF FEED LENGTHS DUE TO ECCENTRICITY OF FEEDING ROLLERS

Number of Stops Per Revolution of Feeding Rollers	1	2	3 & 4	5	6	8	12	20
Maximum Variation Between Longest and Shortest Feed Lengths Due to Eccentricity (e)	0	$4.4e$	$2.9e$	$2.3e$	$2e$	$1.5e$	$1.0e$	$0.6e$

accurate registration with operations performed by preceding elements.

Accurate intermittent feeding of continuous webs is important on many automatic machines for metal, paper, cardboard, plastic, and other materials. This particular discussion will deal specifically with the feeding of metals largely because properties of metals are known better than the properties of other materials, and theoretical calculations are more readily possible. However, many of the considerations involved are similar for other materials.

Three basic feeding arrangements are discussed: 1. Feeding between a pair of cylindrical rollers. 2. Feeding with reciprocating clamps. 3. Feeding around traction drums. Results of experimental investigations are reported, but it should be admitted that the experimental data is meager and the results are open to doubt due to the many factors involved in the process of intermittent feeding.

▶ Factors in Feeding with Rollers

When a web is advanced between cylindrical rollers, the feeding rollers are usually operated by a crank through a ratchet or clutch mechanism. It is difficult to imagine a simpler device; but when high precision and consistency of feed length at high speed are required, many difficulties arise.

First of all, the force providing the feeding depends on the pressure between the rollers and the web and on a coefficient of friction. The latter is affected by many factors which practically eliminate any expectation of consistency. These factors include variations in the following conditions: The web may be dry or lubricated with oil or grease. It may have burrs on its edges from the slitting operation. Its surface may have a mirror finish or be rough. The presence of dirt particles, unevenly distributed, affects the coefficient of friction. The thickness of the web may vary across the web and along it. The web may have lateral long waves instead of having a straight edge.

Also influencing the effective feeding force is the possibility of deformations under the feeding rollers and the fact that frictional resistance to movement of the web may vary due to some of the conditions just mentioned.

Computing Stresses in Webs Due to Pressure of Feed Rollers

WHEN a metal web is advanced by gripping it between feed rollers, the amount of pressure the feed rollers exert on the web is an important factor in determining slippage between web and rollers and therefore the accuracy of the feeding action. Since the pressure of the rollers creates stresses in the web, the maximum pressure used should not create stresses greater than the elastic limit of the web material. If it does, the web will be permanently deformed and the material rolled out to a decreased thickness.

Using relationships developed by Hertz, the stresses in the web due to pressure of the feed rollers can be calculated for various roller diameters, roller materials, and web materials and compared to the elasticity limits. Calculations with the Hertz relationships also allow comparison of feeding results for different roller and web combinations.

An adaptation of the basic equation[1] for the compression stress created by pressure between two bodies, for the case of a roller and a web, is:

$$\sigma = \sqrt{\frac{P(r+\rho)}{\pi^2(k_1+k_2)r\rho}}$$

in which:

σ = maximum compression stress (psi)
P = pressure of a roller on a web (lbs per inch of web width)
r = radius of roller (inches)
ρ = radius of curvature of web (inches)
π = 3.1416
$k_1 = \dfrac{1-\mu_1^2}{\pi E_1}$ (See footnote 2)
μ_1 = Poisson's ratio for roller material
E_1 = modulus of elasticity for roller material (psi)
$k_2 = \dfrac{1-\mu_2^2}{\pi E_2}$ (See footnote 2)
μ_2 = Poisson's ratio for web material
E_2 = modulus of elasticity for web material (psi)

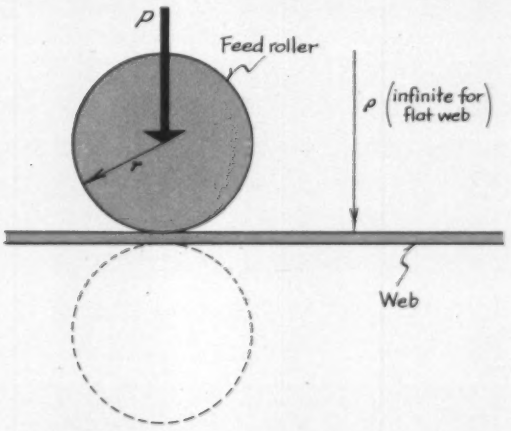
By substitution for k_1 and k_2 and rearranging terms we have:

$$\sigma = \sqrt{\frac{\rho}{r}}\sqrt{1+\frac{r}{\rho}}\sqrt{\frac{E_1E_2}{\pi(1-\mu_1^2)E_2+\pi(1-\mu_2^2)E_1}}$$

[1] For the basic equation see S. Timoshenko and J. N. Goodier—*Theory of Elasticity*, Second Edition, McGraw-Hill Book Co. Inc., New York, 1951, p. 382.
[2] *Ibid.* p. 374.

TABLE 2 · VARIATION OF SLIPPAGE WITH FRICTIONAL RESISTANCE
(With Hertz Compressive Stresses of 12,500; 14,500; and 17,900 psi)

Frictional Resistance in Per Cent of Feeding Force	14%	17-20%	25%	30-34%	38-42%
Average Slippage in Per Cent of Feed Length	0.4%	0.5%	0.6%	0.7-1.0%	1.1-1.3%



And since the web between feed rollers can be assumed to be flat, ρ is infinite and r/ρ is zero, therefore:

$$\sigma = \sqrt{\frac{P}{r}} \sqrt{\frac{E_1 E_2}{\pi(1-\mu_1^2)E_2 + \pi(1-\mu_2^2)E_1}}$$

By substituting values for steel rollers, the last factor becomes

$$\sqrt{\frac{E_1 E_2}{\pi(1-\mu_1^2)E_2 + \pi(1-\mu_2^2)E_1}} = F = \sqrt{\frac{E}{0.95\,E \cdot 10^{-7} + \pi(1-\mu^2)}} \quad \text{(a)}$$

where $E = E_2$ = modulus of elasticity for web material (psi)

$\mu = \mu_2$ = Poisson's ratio for web material

A simplified expression for the compression stress in various metal webs caused by the pressure of steel rollers is then:

$$\sigma = F\sqrt{\frac{P}{r}}$$

where

σ = maximum compression stress (psi)

F = factor calculated from Equation a. For various metal webs approximate values of F are—steel 2300; stainless steel, 2250; brass and copper, 1900; aluminum alloys, 1600

P = pressure of roller on web (lbs per inch of web width)

r = radius of roller (inches)

A second major cause of inconsistency in feeding lengths is due to use of the crank drive. A crank and slide used for oscillating motion gives an acceleration diagram which is called harmonic.

It is truly harmonic because the dynamic forces, due to acceleration and deceleration, change gradually from positive to negative maximum values. This diagram is distorted slightly, however, if the connecting rod is at least eight times longer than the radius of the crank.

The diagram changes greatly when the crank is used to produce an intermittent motion during one half of the revolution of the crank. *Fig.* 1 shows the acceleration diagram in this case. The feeding starts at the point *A* with an instantaneous application of the maximum acceleration and it ends with an abrupt change from the maximum deceleration at the point *B*.

Since mechanisms for intermittent motion—such as a sprag clutch or ratchet and pawl—can only push the feeding rollers forward, the drive should have a brake to absorb the energy during the deceleration from O to *B*, *Fig.* 1. The braking force should be sufficiently great to provide the maximum deceleration at the point *B*.

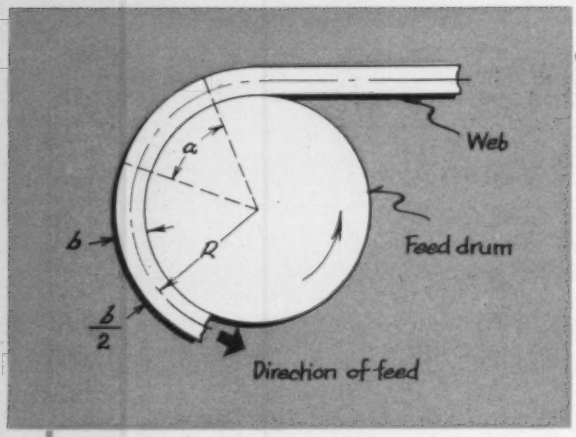
By tradition this acceleration diagram is also called "harmonic" while actually it has two abrupt variations of dynamic forces and therefore has very unfavorable vibrational characteristics. In the case of a ratchet drive there is an impact at the point *A* due to a necessary clearance between the pawl and the ratchet tooth. In case of a clutch, some slippage can be expected at the point *A*.

There is a third group of conditions in the feeding mechanisms which can contribute to variations of feed lengths. They may exist in any mechanism for intermittent motion, and include the following:

1. Eccentricity of feeding rollers (or of any rotating parts of the mechanism) creates a cyclic change of the feed length obtained. Table I shows approximate maximum cyclic variation of feed lengths due to the eccentricity, *e*, for different numbers of stops per revolution of the feeding rollers (or gears). The variations shown represent maximum possible variations between the longest and the shortest feed lengths due to eccentricity. The figures are calculated approximately just to give an idea of the influence of eccentricity.

2. Backlash in the driving mechanism, including clearances in the connecting rod.

3. Backlash in gears connecting the feeding rollers. In many



Computing Stresses in Webs Due to Wrapping Around Feed Drums

WHEN a metal web is advanced by a drum around which it is wrapped, the bending of the web around the drum causes stresses in the web. The amount of stress should be below the elastic limit of the material, otherwise the web will take a permanent set and curl after it leaves the drum.

The sketch indicates a drum with a web of thickness b wrapped around it. Radius of curvature of the centerline of the web is R. Assume that the modulus of elasticity for the web material has the same value for tension and for compression, and for an approximate solution accept that the shape of the web does not change when it is bent around the drum. Therefore, the centerline of the web does not change its length, while the inner and outer surfaces of the web have equal longitudinal deformations.

Length of the centerline, l, of the web, subtended by a selected angle, α, given in radians is

$$l = R\alpha$$

and it remains unchanged during the bending.

Length of the inner surface, l_i, of the web, subtended by the same angle is

$$l_i = \left(R - \frac{b}{2}\right)\alpha$$

and the maximum longitudinal deformation, δ, of the inner surface caused by wrapping the web around the drum is

$$\delta = l - l_i = \frac{b}{2}\alpha$$

Under the conditions given, the outer surface of the web has the same maximum amount of longitudinal deformation.

The ratio of the maximum longitudinal deformation to the original length is

$$\frac{\delta}{l} = \frac{b\alpha}{2R\alpha} = \frac{b}{2R}$$

Since this is the maximum strain due to tension and to compression, the maximum tension or compression stress can be found from the basic stress-strain relationship. Therefore:

$$\sigma = E\frac{b}{2R} = E \div \frac{2R}{b}$$

where

σ = maximum tension or compression stress due to wrapping (psi)
E = modulus of elasticity for web material (psi)
R = pitch radius of web centerline around drum (inches)
b = web thickness (inches)

cases it can be eliminated by having a brake on the upper feeding roller.

4. Stresses in the metal web produced by the pressure of rollers. They can be calculated using formulas based on the relationships developed by Hertz, see box "Computing Stresses in Webs Due to Pressure of Feed Rollers."

In the case of a thin web, the Hertz shearing stresses created by one roller combine with stresses created on the opposite side of the web by the other roller. In such cases the shearing stresses may become critical. In practice, it is best to use lower compression stresses, as calculated from the formula in the box, for web thicknesses less than 1/32 inch, unless careful calculation of shearing stresses is made and their distribution is analyzed.

TABLE 3 · ELASTICITY PROPERTIES OF METAL WEBS

Material	Modulus of Elasticity, E (psi)	Elastic Limit (psi)
Steel	30×10^6	$(20 \text{ to } 60) \times 10^3$
Stainless Steel	27.5×10^6	30×10^3
Brass	16×10^6	$(12 \text{ to } 15) \times 10^3$
Copper	15.5×10^6	$(5 \text{ to } 40) \times 10^3$
Aluminum	10×10^6	$(5 \text{ to } 30) \times 10^3$

▶ Experimental Roller Feed Data

Experiments with feed rollers were made at Ferguson Machine Co., Div., Universal Match Corp., to determine the influence of different factors on the consistency of intermittent feeding. Each length fed was marked automatically by a light scratch on the surface of the web. Lengths of feed between the marks were measured on a comparator, so the precision of the gathered data can be considered closer than plus or minus 0.001 inch.

The feeding rollers made three stops per revolution, and the theoretical feed length (without any slippage) was 4.164 inches. Short strips of steel were used to decrease the influence of inertia of the web, and the surface of the steel was not exceptionally smooth. The thicknesses of the steel webs used were 0.020 and 0.028 inch, so the influence of com-

bined shearing stresses from two rollers was possible. The feeding arrangement was equipped with an adjustable brake on the metal strip so that different resistances to movement of the strip could be introduced.

In setting up the experiments, some of the conditions contributing to variations were avoided. A Ferguson Roller Gear was used which has no backlash. It was driven by a cam which produced a motion with modified trapezoid acceleration and with no abrupt variation of dynamic forces. The feed rollers were ground after mounting on their shafts to eliminate eccentricities, and the shafts were installed on antifriction bearings. Though tests were run at 200 and 267 rpm, the maximum accelerations were only 0.84 and 1.5 times the acceleration of gravity. A brake was installed on the upper roller to eliminate the influence of backlash in the gears linking the upper and lower rollers. This brake was found necessary even in the case of lower accelerations.

Under these conditions, the experiments attempted to restrict variations in feed lengths to those caused by uncontrolled possible variations of the coefficient of friction and controlled variations of roller pressure and frictional resistance to movement of the web. To generalize the presentation of the results, it was decided to present slippage as a per cent of the theoretical feed length, the pressure of the feed rollers in terms of Hertz compressive stresses, and frictional resistance to feeding as a per cent of an estimated feeding force. The experiments were not sufficient to draw definite conclusions, but they provided some indications which may be of interest to engineers working with frictional feeding mechanisms.

The experiments were performed in two general areas. In one, the frictional resistance to movement was insignificant even in comparison with low inertia forces. In the other, frictional resistance was increased by a brake on the metal strip.

In the experiments in which frictional resistance to movement was insignificant, the results were as follows:

1. Average slippage was 0.1 to 0.15 per cent of the theoretical feed length when Hertz compressive stresses were 12,000 to 18,000 psi from one roller.

2. Slippage increased up to 0.3 to 0.4 per cent when the stresses were below 12,000 psi.

3. Slippage increased slightly, up to 0.2 per cent, when stresses reached 20,000 psi; and up to 0.4 per cent with stresses of 28,000 psi.

4. Individual feed lengths varied plus or minus 0.025 to 0.075 per cent. Partially, this variation may have been caused by possible eccentricity of commercial gears connecting the feed rollers.

In the experiments in which frictional resistance was increased by a brake on the metal strip, three values of compressive Hertz stresses were used—12,500; 14,500; and 17,900 psi. The results can thus be compared to those obtained with insignificant frictional resistance and similar Hertz stresses. It was assumed that the coefficient of friction between the brake and web was 50 per cent higher than the coefficient of friction between the feed rollers and the web. The results obtained indicated that average slippage changed with variations in friction resistance as shown in TABLE 2. The results also showed that when the frictional resistance was 30 per cent of the feeding force or higher, the variation of the individual feed lengths became noticeably greater—up to 0.15 to 0.3 per cent. This can be explained by additional shearing stresses due to need for higher feeding force to overcome the resistance. Because of the increased stresses the deformation of the strip became greater.

There are indications that a brake can control the feed length by an increase of slippage between the ranges of 0.1 to 0.15 and 0.6 to 0.65 per cent of the feed length in case of webs 1/32 inch or less in thickness, without an excessive variation of length of individual lengths fed. It may be that thicker webs can be controlled to a greater extent.

However, unfavorable conclusions can be made. The adjustment of the feed length by a brake on the web cannot give a sufficient span of control for a ratchet drive. A brake may be of some help when using a sprag clutch, though the clutch will show a greater wear. For a Roller Gear Drive, brake control may be practical only if a 160-tooth driven gear is used on the lower roller shaft so that a one tooth change in the drive gives 0.67 per cent change of the feed length. However, added inertia of gears will be objectionable. Experi-

TABLE 4 · STRESS DUE TO WRAPPING OF METAL WEBS AROUND DRUMS

		Maximum Stress (psi)							
Ratio of Pitch Diam of Web on Drum to Thickness of Web ($\frac{2R}{b}$)		400	500	600	750	1000	1250	1500	2000
Material	Steel	75,000	60,000	50,000	40,000	30,000	24,000	20,000	15,000
	Stainless Steel	68,750	55,000	45,800	36,700	27,500	22,000	18,300	13,800
	Brass	40,000	32,000	26,700	21,300	16,000	12,800	10,700	8000
	Copper	38,750	31,000	25,800	20,700	15,500	12,400	10,300	7800
	Aluminum	25,000	20,000	16,700	13,300	10,000	8000	6700	5000

ments are being planned for a different method of control of the feed length besides the brake on the web.

For the present it is better to have a constant length feeding mechanism, driven directly by a Roller Gear Drive, especially for progressive dies. The time for changing dies can be shorter without a tedious adjustment of the feed length. Manufacturing plants producing numerous metal items in comparatively short runs (10,000 to 20,000 pieces) can improve the situation by standardizing on a few feed lengths for which different dies are designed. Improvement will be obtained providing the cost of wasted material is less than the cost of time lost in adjusting feed length plus the cost of defective parts made during these adjustments. Though the feeding of metal strips by rollers is not ideal, it can be improved and the speed raised by the use of Roller Gear Drives, especially in cases when changes of feed lengths are seldom made.

Feeding by Clamps

When webs are fed by reciprocating clamps, the whole feeding device has a reciprocal motion. During the forward stroke the metal web is attached to the device by clamps, and during the return stroke the clamps are released. In various designs the clamps are operated by means such as different mechanical or pneumatic arrangements.

Due to the movement back and forth of a heavy mechanism and due to the loss of time for operating the clamps, this method is suitable for slow operations. It can be used for long strokes and for feeding metal strips with a large cross section. As in most cases of roll feeding, feeding with clamps is suitable for pushing a metal web into dies or similar automatic devices.

TABLE 5 · TENSION TO WRAP WEB AROUND DRUM

Ratio of Pitch Diameter of Web on Drum to Thickness of Web ($\frac{2R}{b}$)	Tension (lb for web of 0.1 sq in. cross section)								
Angle to be Wrapped to Reach Action Line of Tension Force	45°	30°	20°	15°	10°	8°	6°	4°	2°
500	15	32.9	73	129	290	452	803	1800	7220
750	6.7	14.6	32.4	57.4	129	201	357	802	3210
1000	3.8	8.2	18.2	32.2	72.4	113	201	451	1800

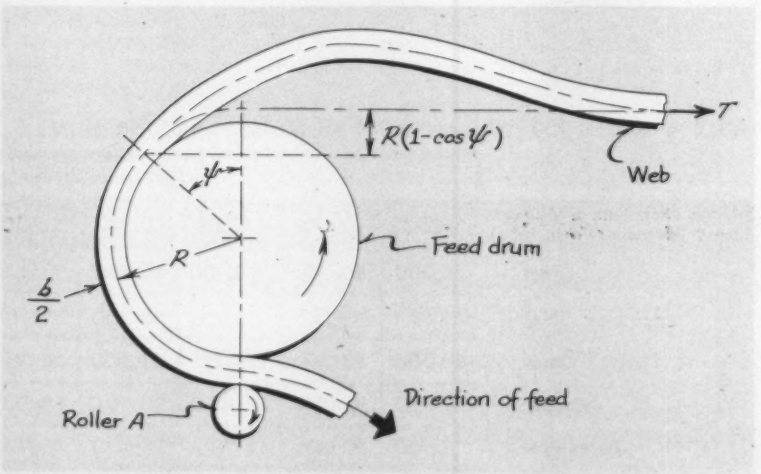


Fig. 2—Sketch depicts feeding of a web by wrapping it around an indexing drum. When the web resists wrapping, it may be pulled against the drum by tension in the web. This solution is not feasible for small values of the angle ψ.

▶ Feeding by Traction Drums

Webs can also be advanced intermittently by wrapping them around a drum which is rotated in desired steps. To provide proper traction a metal web should be wrapped around the drum approximately 180 degrees.

Since this method is suitable for comparatively thin and flexible metal webs, it has to be used for pulling the web from a die because a thin web may buckle when it has to be pushed out of the die. When the drum is used for pulling the used web from the die, a small pressure at the end of the wrap can provide a good feeding force due to the snubbing action of the 180-degree wrap. Besides, the die will leave punched out spaces in the web or special holes can be punched, and if the drum has suitable projections, any possibility of slippage of the web will be eliminated.

The difficult point in this design is to turn the drum on a precise angle during each step. We solved this problem by using a Ferguson Roller Gear which effects the rotary indexing with precision.

To decide the limits presented by drum feeding it is necessary to determine two basic factors. These factors are: 1. Stresses in the metal web when it is wrapped around the drum. 2. Forces and means necessary to keep the web clinging to the surface of the drum.

Procedure for determining the critical stresses is presented in the box "Computing Stresses in Webs Due to Wrapping Around Feed Drums." Using this procedure, stresses have been calculated for several materials, with properties shown in TABLE 3. Where ranges of values are indicated for elastic limits, the low limits are for softer grades of material. In feeding those softer materials, larger drums should be used unless it is acceptable to have a deformed web after it leaves the drum. Stresses calculated for various values of the ratio of pitch diameter of the web on the drum to thickness of the web ($2R/b$) are show in TABLE 4.

Determining of the moment necessary to bend the web around a feed drum is possible with a conventional engineering formula[1]. The bending moment with which the web resists wrapping around a drum is

$$M = \frac{EI}{R(1-\mu^2)} \qquad (1)$$

in which

M = bending moment (lb-inch)
E = modulus of elasticity of web material (psi)
I = moment of the area of the rectangular cross section of the web about its centerline (inch^4)
R = pitch radius of web on drum (inch)
μ = Poisson's ratio for the web material

In this case of a web with width, w, and thickness, b, wrapped around a drum,

$$I = \frac{wb^3}{12} \qquad (2)$$

[1] S. Timoshenko—*"Strength of Materials, Part II,"* D. Van Nostrand Co. Inc., New York, 1930, p. 475.

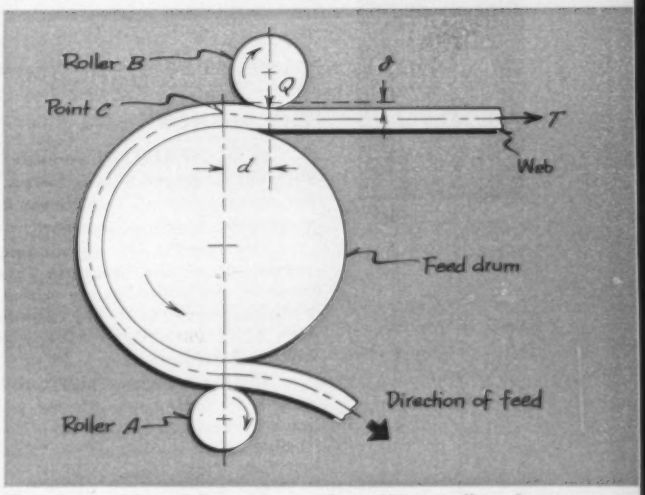


Fig. 3—Drawing indicates use of auxiliary roller, B, to wrap a web around a feed drum when tension in the web will not satisfactorily bring this about. Due to bending of the web, roller, B, must deflect web below tangent at desired point of contact with drum.

Then from Equation 1 and 2:

$$M = \frac{Ewb^3}{12R(1-\mu^2)} \qquad (3)$$

This moment should be balanced by the forces applied to wrap the web around the drum. When the force to wrap the web is to be supplied by tension in the web, the situation is indicated by *Fig.* 2.

It is assumed that the tension force T is applied along the tangent to the pitch line of the web on the drum. The shape of the web from the line of contact between web and drum to the action line of the tension force is neglected since the force can be assumed to act at any point along its line of action. The outgoing leg of the web is held against the drum by a roller, A, which should be driven, on antifriction bearings, or both.

At a given time the web may be already wrapped around the periphery of the drum from the roller, A, to a point which is on an angle, from the perpendicular to the action line of the tension force. The bending moment created by the tension about the neutral axis, which in this case is the centerline, of the web at the point of web and drum contact is $M = TR(1 - \cos\psi)$. This moment should counterbalance the moment with which the web resists bending, Equation 3, therefore:

$$TR(1-\cos\psi) = \frac{Ewb^3}{12R(1-\mu^2)}$$

from which:

$$T = \frac{Ewb}{3(1-\mu^2)(1-\cos\psi)} \div \left(\frac{2R}{b}\right)^2$$

To assess the values of T required for various conditions, results in TABLE 5 were calculated for a

THE AUTHOR

C. N. NEKLUTIN recently retired from his position as Vice-President of Engineering, Universal Match Corp., and will devote his time to consulting work based on his many years of experience in cam design, special machines, tooling, plant layout, production methods, and cost accounting.

His interest in cam design, for which he is a recognized authority, led to development of the Ferguson Roller Gear Drive. He has also contributed many other ideas in the design and speeding up of automatic machines used for paper converting, printing, assembly, candy making, and production of pyrotechnic and metal products. One of his investigations was an original study of dynamics of automatic machines including vibrations.

During his years with Universal Match he developed layouts for many production plants, including several war plants. He also developed a cost estimation system for mass production plants and installed it. Some of his thinking in this area was recorded in an earlier article "Automation Economics Requires Engineered Accounting," AUTOMATION, Nov. 1957.

Mr. Neklutin was born in Samara, Russia, and attended St. Petersburg Polytechnic Institute. He came to the United States in 1923, starting his long association with Universal Match shortly thereafter. He is a Registered Professional Engineer.

steel web with a cross-section, wb, of 0.1 sq in.; $E = 30 \times 10^6$; $(1-\mu^2) = 0.91$; and for three values of the ratio of pitch diameter of web on drum to thickness of web, $(2R/b)$.

Since the force, T, was calculated for a cross section of 0.1 sq in., it will create a tension stress in the web of $10T$ psi which will be excessive for small values of the angle ψ. Also, high values of T will increase the torque required to drive the drum.

It is evident that the tension force should not be used for wrapping the web to values of the angle ψ smaller than 15 to 20 degrees because of the higher tension forces required at the smaller angles. An additional force should be introduced to finish wrapping the web and bring the angle ψ to zero. As shown in *Fig.* 3, another roller, B, can be used to apply a force, Q, which acts at a distance, d, from the point C.

To wrap the web against the drum, the moment Qd should be equal to the moment calculated from Equation 1. Therefore:

$$Q = \frac{M}{d} = \frac{EI}{dR(1-\mu^2)} \qquad \text{4}$$

Actually the roller, B, should depress the web below the tangent to the web centerline at C if the web is to be against the drum adjacent to C. The amount of depression is the deflection, δ, created by force, Q, on the free end of a cantilever beam of length, d. This deflection is[2]

$$\delta = \frac{Qd^3}{3EI}$$

and substituting from Equation 4, we have:

$$\delta = \frac{d^2}{3R(1-\mu^2)}$$

When applied to a steel web for which $(1-\mu^2)$ equals 0.91 and a drum giving R equal to 5 inches, the deflection will be 0.018 inch for a d of 0.5 inch and it will be 0.073 inch for a d of 1.0 inch. It can be seen that small values of d decrease δ and increase the force, Q, required. Increased force is not objectionable since it provides a larger frictional resistance preventing buckling of the web between the roller B and point C. The roller B can be replaced by a stationary guide, if the friction will not damage the web excessively.

Since the drum pulls the web from a die, material will in many cases be removed from the web before it touches the drum. The effective width w which is used in calculation will therefore frequently not be the original width of the web, so a modified width should be determined and used in computations. A very thin and flexible web will not require the roller, B, since its action may be performed by the weight of the web in combination with the tension in the web.

When the feeding drum is driven by a Roller Gear, changes of the feed length can be made only in steps. The step changes can be accomplished by having a large gear on the drum shaft and using change gears on the Roller Gear shaft. In such cases the gears should be carefully designed to decrease the possibility of eccentricities.

Using these general considerations as a guide, various methods of intermittent web feeding can be evaluated for specific applications. Where materials other than those mentioned are to be fed, evaluations can be made in many cases by substituting the appropriate values for web properties.

[2]S. Timoshenko and G. H. MacCullough—"*Elements of Strength of Materials*," Second Edition, D. Van Nostrand Co. Inc., New York, 1940, p. 170.

CLASSIFYING GLASS BLANKS BY WEIGHT

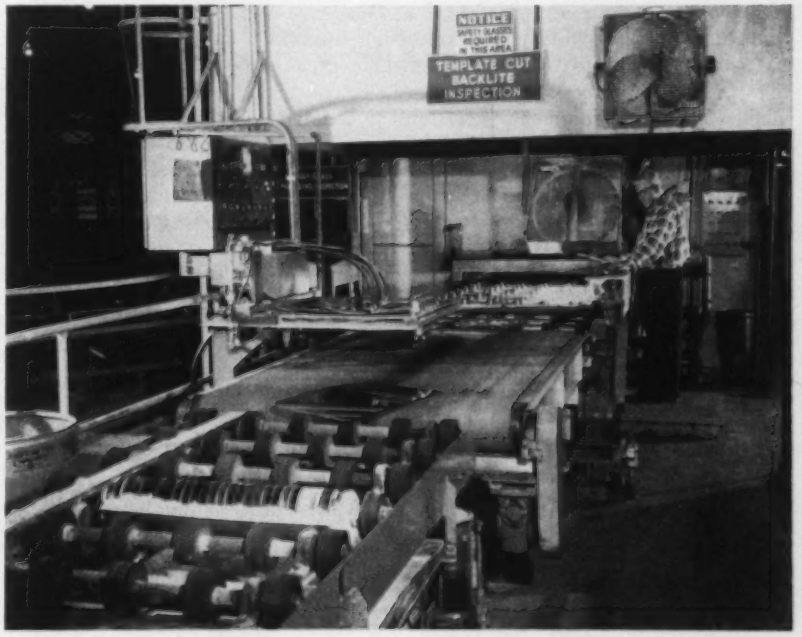
IN THE FABRICATION of curved side and rear window glass for installation in automobiles, sheets of glass are cut into outline form and then bent to a curved shape in a forming oven. The nominal glass thickness is ¼ inch, but, under normal operating conditions, individual pieces may vary from minus five per cent to plus eight per cent of the prescribed thickness. Since very slight variations in thickness will affect the glass bending rate when heat is applied, the glass blanks must be gaged and classified prior to bending.

At the Ford Motor Co. glass plant in Dearborn, Mich., glass gaging and classification is accomplished on an automatic high-speed checkweighing system designed and built by Thayer Scale Co. In operation, a weighing conveyor carries the glass blanks past a weigh station on a continuous flow basis at a rate of approximately one glass every seven seconds. As the scale weighs each blank, it automatically classifies the weight into one of five categories and identifies the part by spraying a dab of color on one corner of the glass, using a different color for each weight category. When a blank is over or under the weight range covered by the five categories, the scale indicates a reject by means of a flashing light.

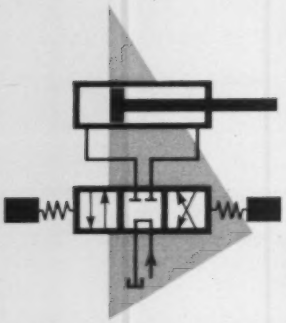
The scale mechanism has no pivots and is completely free of wearing parts. The weight beam and levers are suspended from patented steel flexure plates that permit frictionless movement without significant movement in themselves. Since there is no rolling or contact friction, the mechanism is impervious to abrasive glass dust, shock, vibrations, and variations in temperature. A zero-setting control permits instant resetting of the scale prior to each weighing run in order that accuracy may be kept constant.

As each weighment is made, the resultant value is transmitted electrically to an amplifier which operates a solenoid triggering the proper paint spray nozzle. Potentiometers for each weight category provide voltage range limits for automatic classification. Upon discharge from the weighing conveyor, each glass blank is loaded onto one of five trucks, according to weight category. Blanks of the same weight are then processed through the forming oven on a "batch cycling" basis.

The forming method by which the correct curves are obtained in a glass blank makes use of a cross-catenary suspension fixture which supports the glass as it is conveyed through the forming oven. By precisely controlling the application of heat in relation to the speed of the conveyor, the glass softens to a point where it begins to sag or bend under its own weight. This "sagging" is allowed to proceed until the glass reaches its desired shape which is only partially determined by the fixture. At this point in the process, the curved glass is cooled at a controlled rapid rate. Very slight variations in individual blank thickness would affect the temperature-time relation where proper form is reached, thus making necessary the gaging-classifying operation prior to bending.



Glass blank checkweighing station is part of a processing line for making curved side and rear windows for automobiles. Glass blanks are conveyed from a washer-dryer unit in the background, past a visual inspection station, and onto the belt conveyor of the weighing station. The scale mechanism weighs each blank and actuates one of five paint spray nozzles to apply a spot of color to the blank, depending upon the weight category of the blank. The blanks are then collected by weight categories and processed through a forming oven in batches.



Part 3

ADJUSTABLE SPEED HYDRAULIC DRIVES

INDUSTRIAL HYDRAULIC CIRCUITS

Increasing numbers of automatic production machines and systems require the versatility of adjustable speed drives. The use of such drives is indicated where speed, torque, or horsepower requirements change during processing or during an operating period; where the speeds of interrelated operations in a line must be synchronized in preset ratios; and where operating conditions must be changed to accommodate different product types or sizes. In this third part of a four-part series on industrial hydraulic circuits, the author discusses advantages and applications of hydraulic adjustable speed drives.

By **R. A. SHARTLE**, Machinery Hydraulics Div., Vickers Inc., Springfield, N. J.

HYDRAULIC pumps, motors, and valves have become important components in adjustable speed drive systems for a wide range of equipment. A partial list of applications includes: Machine tools, printing and paper converting machinery, construction and road building machinery, textile and allied processing machinery, conveyors, metal extrusion equipment, steel mill machinery, material handling equipment, and farm machinery.

The broad acceptance and utilization of adjustable speed hydraulic drives in industry is due to the numerous advantages offered by these units. Major features that make such drives particularly suited to modern production equipment are listed in the box entitled "Characteristics of Adjustable Speed Hydraulic Drives." Another factor contributing to the success of adjustable speed hydraulic drives is the development of improved control elements such as electrohydraulic servo valves. Controls of this type are now used in automatically programmed cycles to enhance the precision and speed of a variety of machines.

A basic adjustable speed hydraulic drive includes a constant or variable delivery hydraulic pump that delivers oil, under controlled pressure, to a constant or variable displacement motor. Output speed and/or torque is controlled by varying the delivery from the pump and/or by varying the displacement of the motor.

Maximum permissible torque is controlled by the pressure setting of an adjustable-pressure relief valve placed in the circuit between the pump and motor. Additional hydraulic controls include valves that control auxiliary pressures, directions, and rates of flow of oil in the hydraulic circuit. The source of pump input power may be an electric motor, diesel engine, or a power take-off from the machine to which the hydraulic drive is related.

Piston, gear, or vane type pumps and fluid motors may be used in adjustable speed hydraulic drives. Piston pumps and motors are invariably used when an application calls for accurate positioning, speed regulation, high over-all and operating efficiencies, and large torques.

▶ Speed Control Methods

Where a single speed adjustment with close regulation is required, a fixed delivery pump, a relief valve, a fixed delivery motor, and a manually adjustable flow control valve are generally used, *Fig.* 20. The flow control valve may be installed on the inlet side of the motor ("meter-in"), on the out-

Characteristics of Adjustable Speed Hydraulic Drives

- Infinitely variable regulation of output speed, torque, and horsepower can be accomplished easily and accurately.
- Maximum torque available at startup.
- Capable of smooth, stepless acceleration and deceleration. Low inertia of rotating drive elements permits rapid starting, stopping, and reversal with smoothness, accuracy, and precision.
- Can be stalled for extended time periods without damage.
- Power source, electrical controls, and pump can be located remotely from fluid motor. Feature is useful in applications where equipment must be operated in explosive atmospheres.
- Inherent self lubrication promotes long life of hydraulic components.
- Low over-all weight and size versus horsepower transmitted.
- Easily adapted to many types of input power sources.

let side of the motor ("meter-out"), or in parallel with the motor ("bleed-off").

Choice of location of the flow control valve in the circuit depends upon the application. For example, meter-in and meter-out arrangements provide similar performance characteristics when the hydraulic motor drives the load. However, the meter-out circuit resists overhauling or overrunning by the load, while such a condition might evacuate the motor with a meter-in connection. With a bleed-off circuit, motor speed may be reduced below maximum without bypassing oil through the relief valve in the circuit. Thus, the pump need not operate at relief valve pressure or pressure corresponding to maximum torque when less than maximum torque is required by the load.

Pressure compensated flow control valves may be used where improved speed regulation is required. Once the flow control valve is set for a given application, it will not usually require readjustment. Speed control is excellent, with minimum variations due to pressure or load fluctuations.

Where variable speed drive characteristics are required, a variable displacement unit must be used at one or both ends of the transmission. To vary the speed of a piston unit, a control assembly positions a yoke on the pump or motor to change the piston stroke between maximum and minimum displacement positions. Range of adjustment is determined by the component used and the specific application.

When it is located on the pump end of a transmission, the control assembly regulates the output delivery of the pump and, hence, the output speed and horsepower of the fluid motor. When it is located on the motor end, the control assembly regulates the output speed and torque of the motor. The basic types of control assemblies include:

Stem Control. This is a straight push-pull type of mechanism that can be actuated manually or automatically through a mechanical linkage.

Handwheel Control. Displacement of a hydraulic pump or motor may be controlled manually by means of a handwheel.

Cylinder Control. A control cylinder may be arranged to move the yoke of a variable displacement pump or motor. This type of control permits the selection of two displacement positions. It can be used with a fluid motor to provide low and high torque operation or with a pump to provide two different delivery rates. An auxiliary pump supplies pressure at approximately 50 to 75 psi through valves that actuate the control cylinder.

Servo Control. A modification of stem control, servo control employs a hydraulic boost mechanism to position the yoke of a variable displacement pump or motor between its adjustment limits. This type of control is used with pumps and motors where the mass to be positioned is relatively large. Hydraulic boost pressure of about 50 to 75 psi is supplied from an auxiliary source.

Pressure Compensator Control. Used on a pump, this control automatically adjusts pump delivery to maintain the volume requirements of the hydraulic system at a preselected operating pressure. With the control, maximum pump delivery is maintained continuously at all pressures

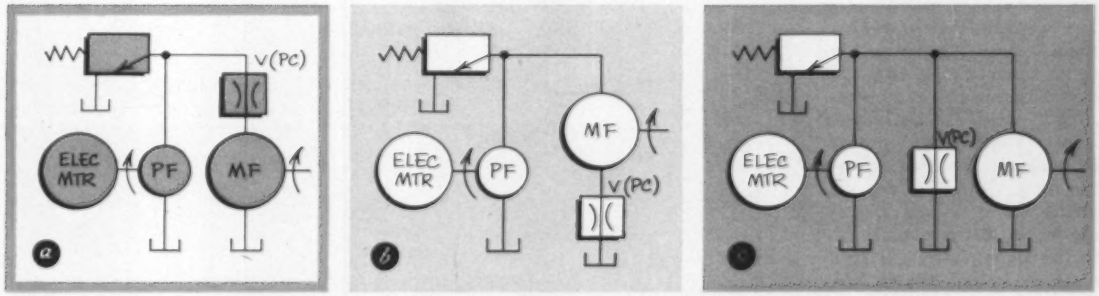


Fig. 20—Speed of a fixed displacement hydraulic motor may be adjusted manually with any of three arrangements shown. Circuits are identified by locations of flow control valves as: meter-in, *(a)*; meter-out, *(b)*; and bleed-off, *(c)*. Fixed delivery pumps are used, with maximum system pressure controlled by setting of relief valve.

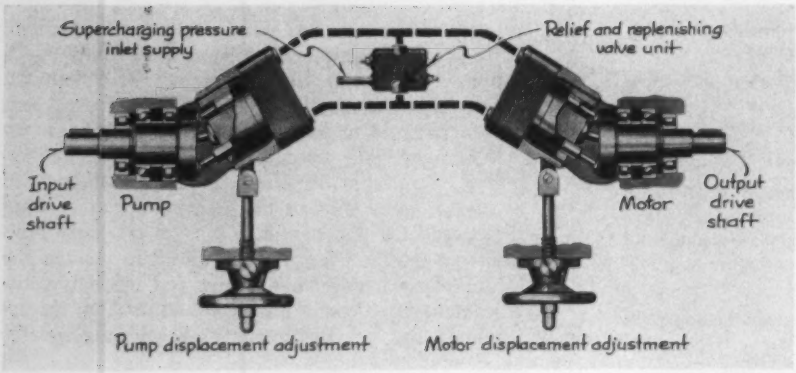


Fig. 21 — So-called "split" drive enables remote location of pump at input power source with fluid motor connected to load. Arrangement shown includes individually adjustable, variable displacement, piston type pump and motor.

up to control pressure. Used on a motor, a pressure compensator control automatically adjusts motor output torque and speed at a preselected pressure level to meet changing work load requirements.

Types of Hydraulic Drives

Hydraulic drives are available in two basic configurations: Integral and split. In the integral drive, the pump and motor are combined in a single housing. In a split drive, the pump may be located at the main power source and the motor may be mounted at the load. A split drive using a piston type pump and motor is illustrated in *Fig.* 21. Split drives are advantageous where the mounting space available at the load is limited, or where the driven unit is in an explosive atmosphere.

The hydraulic circuit for a drive may be either an open or closed type. An open circuit, *Fig.* 22*a*, is one in which exhaust fluid from the motor is discharged to a reservoir. The pump draws its supply of oil from the same reservoir. In a closed circuit, *Fig.* 22*b*, the exhaust fluid from the motor is returned directly to the pump intake port. Drain lines are used to return internal leakage within system components to an oil reservoir.

Choice of an open or closed hydraulic circuit depends upon factors such as the type of pump used and the performance characteristics required. For high performance, a closed circuit employing a piston type pump is generally used. For best possible performance, the piston pump in a closed circuit may be supercharged. With an open circuit, any type of pump may be used. Performance is then a function of the type of pump used, being higher for piston units and less for vane and gear pumps in that order.

Adjustable speed hydraulic drives may also be classified according to the types of output characteristics required. An analysis of the characteristics of the driven machine elements will usually determine the best type of drive for the job. Major classes of drives, according to output characteristics, include:

Constant Torque, Variable Horsepower. A typical constant torque, variable horsepower drive includes a constant displacement fluid motor connected to a machine element. Fluid is supplied to the motor from a variable delivery pump or from a variable flow control valve. This type of drive is well suited to constant torque applications such as machine tool feeds, the main drives of printing and

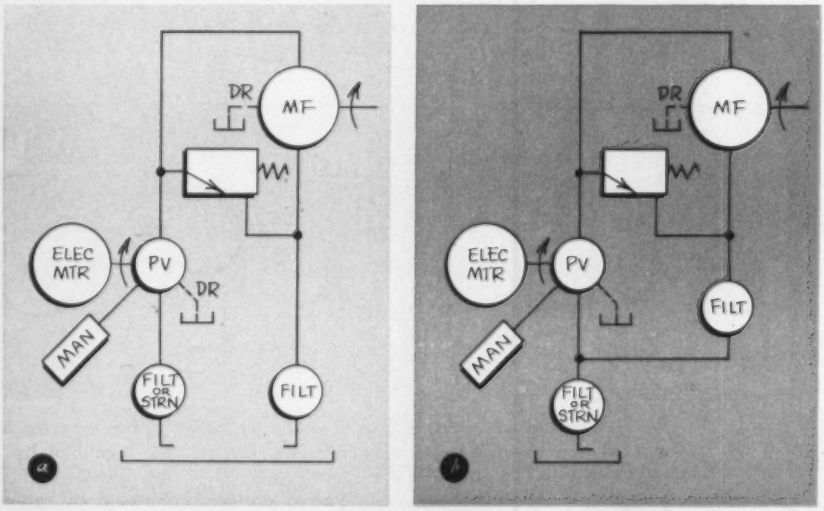


Fig. 22—Two types of piping arrangements for adjustable speed hydraulic drives include open circuit, *(a)*, and closed circuit, *(b)*. In an open circuit, fluid is discharged from the motor into a tank or reservoir. The pump draws its supply of oil from the tank. In a closed circuit, the motor discharges directly to the pump inlet. A small reservoir is included to handle leakage losses.

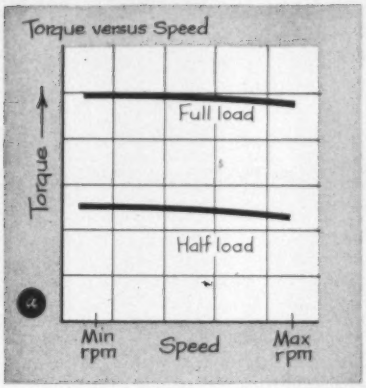
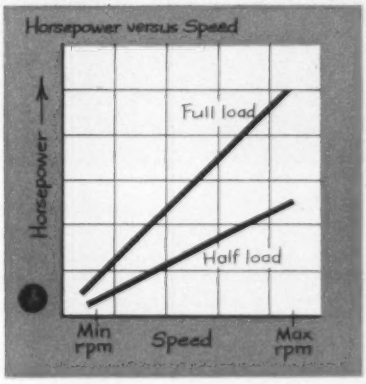


Fig. 23—Constant torque, variable horsepower drive provides uniform torque throughout speed range when operated at a constant pressure, *(a)*. Horsepower increases with speed, *(b)*.



processing machinery, foundry and continuous casting equipment, textile machinery, elevators, hoists, and winches.

The diagram of *Fig.* 22*a* is that of a constant torque, variable horsepower drive. The adjustable relief valve, shown between the pump and motor, limits the maximum fluid pressure developed by the pump. This, in turn, limits the maximum output torque of the motor. Since the motor is a constant displacement type, the output torque of the motor, at a constant pressure, will remain essentially constant at any speed from minimum to maximum, *Fig.* 23. Speed of the motor is controlled by the volume of oil delivered from the variable delivery pump per unit of time.

A constant torque, variable horsepower drive employing a closed supercharged circuit is diagramed in *Fig.* 24. Maximum efficiency of this drive is attained when the motor is using the full delivery of the pump. At less than full delivery the efficiency becomes lower. However, it remains much higher than the efficiency attainable with a circuit using a flow control valve to control output speed by varying the volume of oil delivered to a fluid motor. Efficiency is also greater than that possible with a circuit using flow control valves to control the speeds of several motors by dividing the flow from a single pump among the motors. The horsepower input to the single pump in such a circuit is generally greater than the total horsepower required for a system using separate variable delivery pumps. With circuits using flow control valves, heat rejection and control of circuit temperature levels can also pose real system design problems. However, size and cost considerations may dictate use of such circuits.

A constant torque, variable horsepower drive similar to that shown in *Fig.* 24 is used on a large anode casting machine, *Fig.* 25. Machines of this type are available with casting wheels from 30 to 40 feet in diameter and are used for the continuous casting of copper billets. Molds, evenly spaced around the wheel, are moved intermittently from station to station. In the drive, oil is delivered to a fixed displacement fluid motor from a remotely located, variable delivery pump driven by an electric motor. An adjustable speed hydraulic drive is particularly advantageous in this application because it provides smooth acceleration, deceleration, reversal, and positioning of the mold-carrying wheel.

Constant Horsepower, Variable Torque. In this type of drive, the output torque of a fluid motor is infinitely variable throughout its speed range. This characteristic is useful in drives for coiling machines, planer and machine tool cutter heads, tension control devices, unwind and rewind machines, and mixing vats.

In operation, a variable displacement fluid motor, directly connected to the machine element, receives oil from a constant displacement pump. Output speed and torque are governed by the displacement angle of the motor. Since the pump is delivering a constant volume of oil at the pressure setting of the compensator control on the fluid motor, the

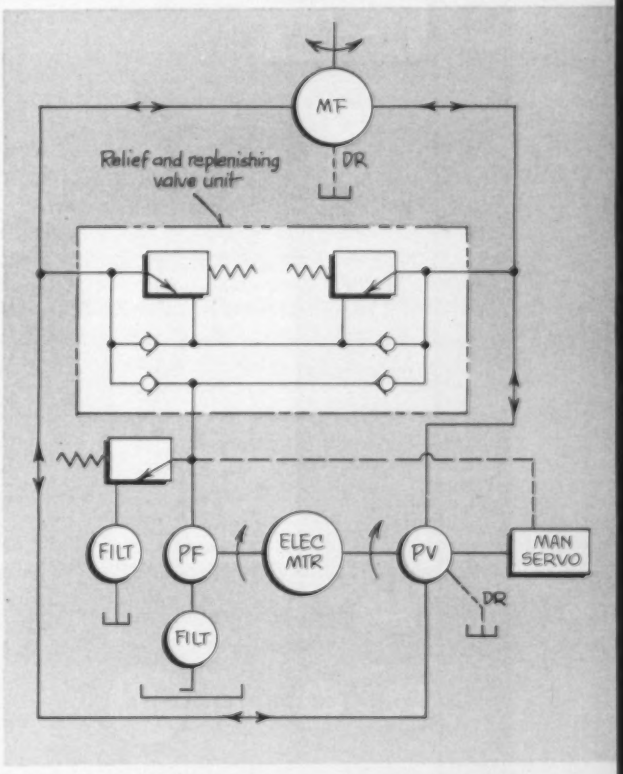


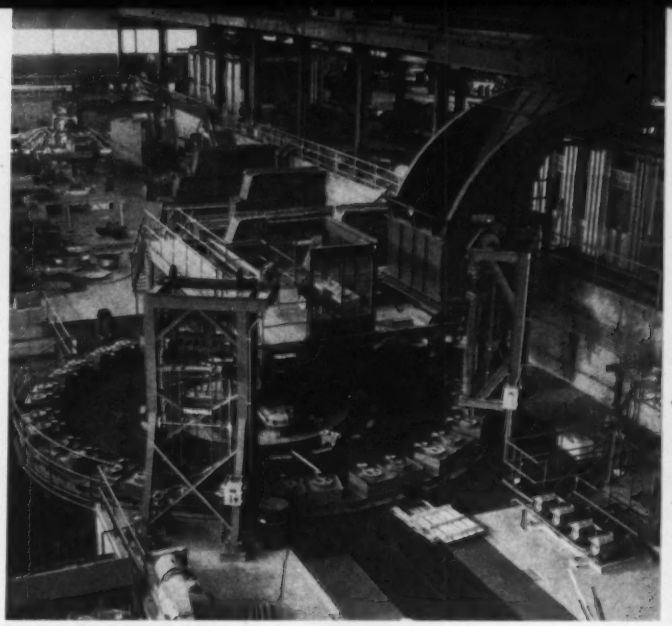
Fig. 24—Split drive employing closed, supercharged circuit can be reversed by means of control on variable delivery pump. Output characteristics of drive are constant torque, variable horsepower versus speed.

motor operates at minimum speed and produces maximum torque when the yoke is at maximum angle. The output speed will increase, and torque will decrease, as the angle of the yoke is reduced.

The drive shown schematically in *Fig. 26a* illustrates the use of a constant horsepower, variable torque drive to control tension on a rewind roll. Torque and horsepower characteristics of this type of drive are shown in *Fig. 26b* and *c*. The speed ratio of the drive is limited to the maximum displacement variation of the fluid motor. Usually, this is approximately 4 or 5 to 1.

A constant horsepower, variable torque drive is also used for controlling the take-up capstan on a rod shaving and wire drawing machine. A hydraulic drive was selected rather than an electric or mechanical drive because it is necessary to maintain lineal tension on the wire while the main machine drive is stopped. Also, the hydraulic drive makes it a simple matter to relieve the tension and reverse the fluid motor in order to thread the wire through the machine.

In the circuit, a fixed displacement pump, driven by the main machine drive, delivers oil in a closed circuit to a variable displacement fluid motor connected to the take-up capstan. Motor speed is remotely controlled by pushbuttons which operate a gear head electric motor to position the control



Courtesy, M. H. Treadwell Co.

Fig. 25—Rotary wheel of continuous copper casting machine carries molds between operations in production of billets. Constant torque, variable horsepower hydraulic drive provides smooth acceleration and deceleration of wheel to avoid displacing molten metal in molds.

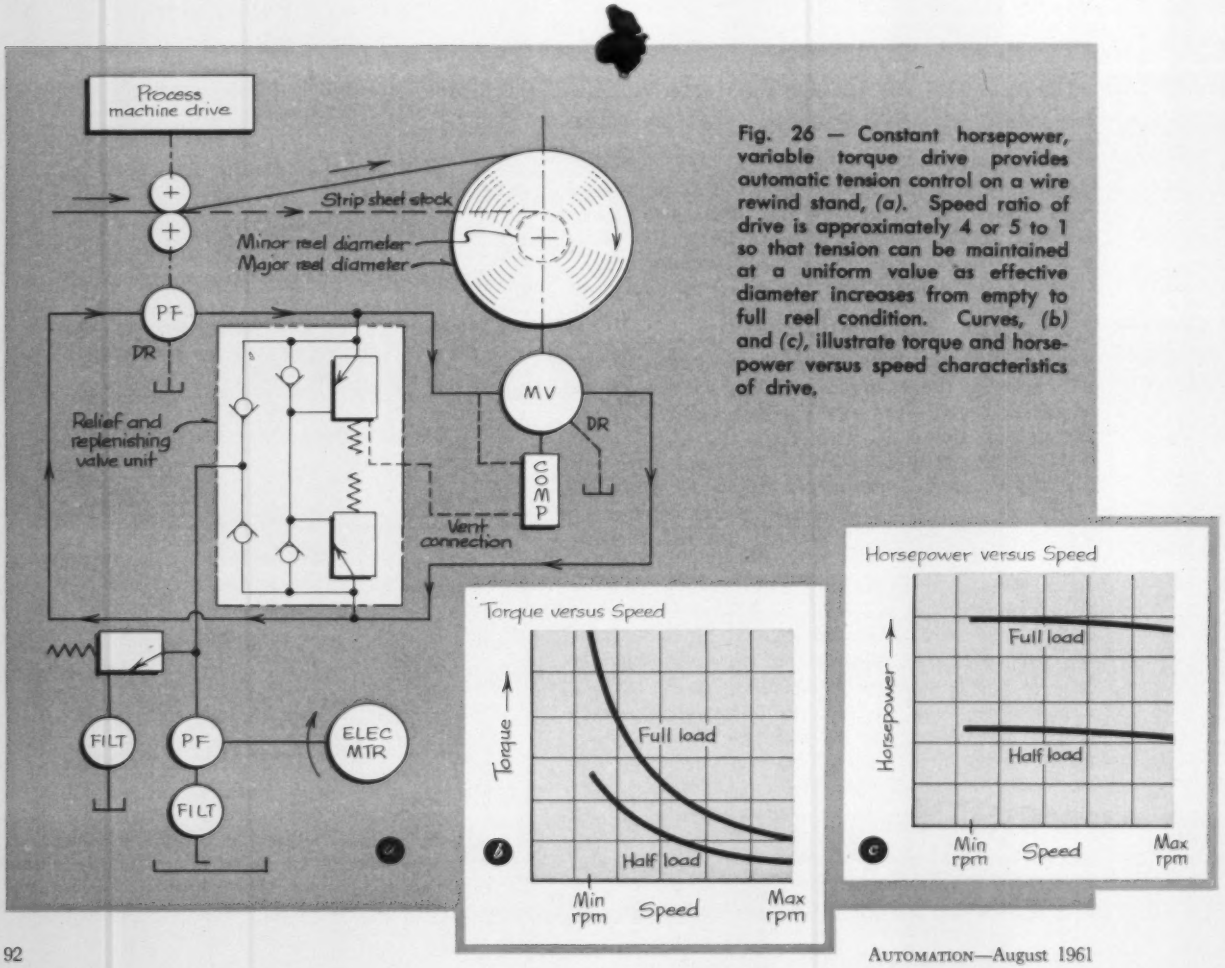


Fig. 26 — Constant horsepower, variable torque drive provides automatic tension control on a wire rewind stand, *(a)*. Speed ratio of drive is approximately 4 or 5 to 1 so that tension can be maintained at a uniform value as effective diameter increases from empty to full reel condition. Curves, *(b)* and *(c)*, illustrate torque and horsepower versus speed characteristics of drive.

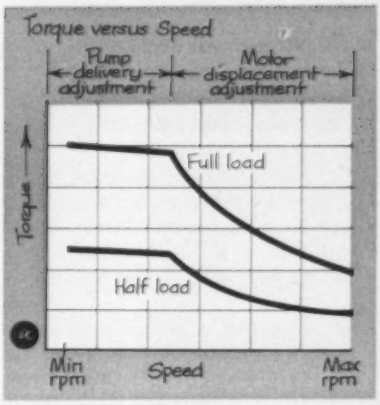


Fig. 27—Adjustable speed hydraulic drives that use variable displacement pumps and motors can provide various combinations of torque and horsepower versus speed characteristics. As shown in the curves, (a) and (b), constant torque, variable horsepower operation can be obtained at constant pressure as drive speed is increased. This is accomplished by increasing pump displacement with fluid motor held in its maximum displacement position. With the pump held in a maintained displacement position, constant horsepower, variable torque action can be secured with increasing speed and constant pressure by decreasing fluid motor displacement. In some drives, constant horsepower is obtained throughout speed range by varying pump and motor displacement simultaneously.

yoke of the fluid motor. The displacement or output torque of the fluid motor controls the lineal tension in the wire being wound on the capstan.

Another application of a constant horsepower, variable torque hydraulic drive is in a multistation acetate foil mill. In the circuit, three flow control valves are used to divide the flow of oil from a single, fixed delivery pump to three variable displacement fluid motors. Each motor drives a separate mill station. The space requirements for this hydraulic drive are less than one fourth of those for an electric drive, and the cost is about 50 per cent less.

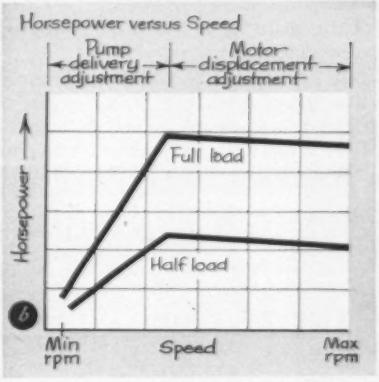
Variable Horsepower, Variable Torque. An adjustable speed hydraulic drive that includes a variable delivery pump and a variable displacement motor is generally used for applications requiring a combination of torque and horsepower characteristics. This type of drive is also advantageous in applications requiring a wide speed range. The torque and horsepower characteristics of such a drive are shown in *Fig.* 27.

As displacement of the pump is increased with the fluid motor maintained in its maximum displacement position, essentially constant output torque, at a constant pressure, is obtained with increasing speed and output horsepower. With the variable delivery pump in a maintained displacement position, essentially constant horsepower is obtainable with decreasing torque and increasing speed at a constant pressure. In some installations, pump and motor displacement positions are controlled simultaneously to provide constant horsepower throughout the speed range.

The circuit of *Fig.* 28 is that of a variable horsepower, variable torque drive used for controlling the peripheral speed of the rewind rolls on a multispindle slitting machine where close control of preset lineal velocity and tension is required. The drive provides a wide range of speed and torque.

A variable delivery pump is connected directly to the machine drive and delivers oil to a variable displacement motor connected to the rewind rolls. Oil passing through the motor is returned to inlet port of the pump, completing a closed loop.

During the slitting operation, the machine pulls the web from the mill roll at a constant lineal speed. As the rewind roll builds up in diameter, the roll positions an arm to actuate cams riding against the roller-operated stem controls of the pump and motor. Simultaneously, the displacements of the



pump and motor are changed to maintain constant lineal speed and tension on the web.

An auxiliary pump is used to supercharge and replenish oil lost from the system. Auxiliary valving in the circuit maintains constant lineal tension on the web from standstill through its entire build-up range, eliminating slack or loss of tension when the main machine drive is stopped. Additional valving is provided to allow free-wheeling of the rolls for loading or unloading the mandrels.

Many variations of this drive have been used to suit special requirements. Small slitters, which do not require excessive build-up ratios, can use a constant displacement fluid motor instead of a variable displacement unit. The hydraulic drive is a constant torque unit and tension is varied by controlling the oil pressure in the circuit between the driving pump and the motor.

A hydraulic circuit for the main drive roll and loom beam of a slasher, *Fig.* 29, incorporates several interesting features including the use of two, series-connected fluid motors driven by a single pump. A second pump is used to replenish small leakage losses in the main operating circuit and to supply pilot pressure for the system.

A slasher is a machine that draws multiple strands of yarn through a sizing solution to protect the yarn against abrasion during weaving. After it is sized, dried, and separated, the yarn is wound onto a loom beam.

Requirements for the slasher drive include the ability to change the processing speed in accordance with moisture conditions in the yarn, and to

maintain constant tension in the yarn as material builds up on the loom beam. The total horsepower required is proportional to the lineal velocity of the yarn and the total tension imposed on the yarn.

In normal slasher operation, the lineal velocity of the yarn is changing continuously to accommodate changes in moisture content of the yarn. These speed changes are accomplished by a control system that includes a moisture sensing device riding in contact with the yarn. Signals from the device are used to operate a geared electric motor on the variable delivery drive pump. The electric motor adjusts the delivery of the pump to change the speed of the fluid motor for the main drive roll in accordance with yarn moisture conditions. Output characteristics of the main drive roll fluid motor are constant torque, variable horsepower.

The loom beam rewind motor is connected in series with the main drive roll motor so as to provide synchronized operation of the two units. Tension in the yarn between the main drive roll and the loom beam is controlled by a pressure-responsive tension regulating control on the variable displacement loom beam drive motor. Operating characteristics of this motor are variable torque, constant horsepower. With the arrangement a stepless, 10 to 1 range of speed is obtainable to maintain essentially constant tension in the yarn throughout the build-up of a beam having up to an 8 to 1 diameter differential.

A novel feature of the replenishing pump subsystem is that oil from the constant delivery replishing pump is circulated through a cooling radiator and then through the housings of the main drive roll fluid motor, the loom beam rewind motor, and the main variable delivery hydraulic pump before it is returned to a reservoir. The circuit provides additional cooling for these main slasher drive components.

Conclusions

Adjustable speed hydraulic drives are an excellent means for converting a constant speed rotary

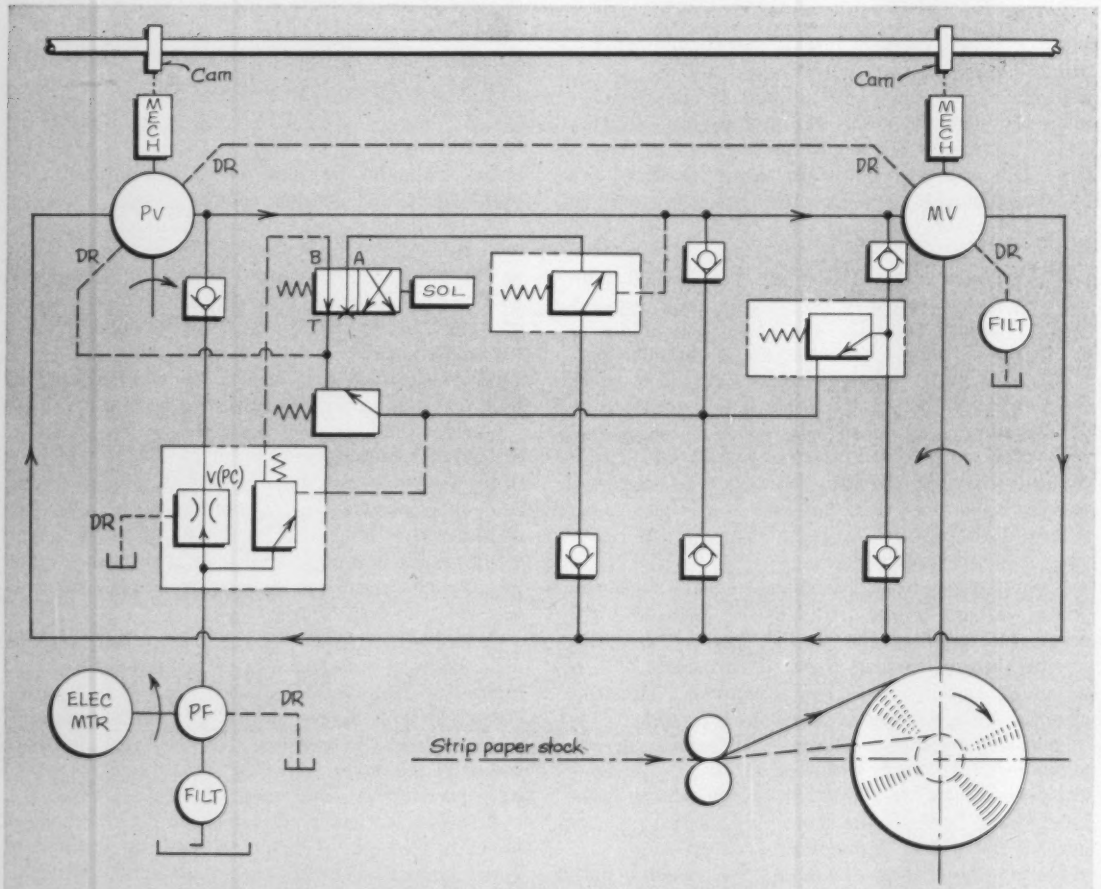


Fig. 28—Variable horsepower, variable torque drive is used to control rewind rolls on a slitting machine. Stem controls on both pump and motor are operated from a common camshaft for accurate response to speed change requirements.

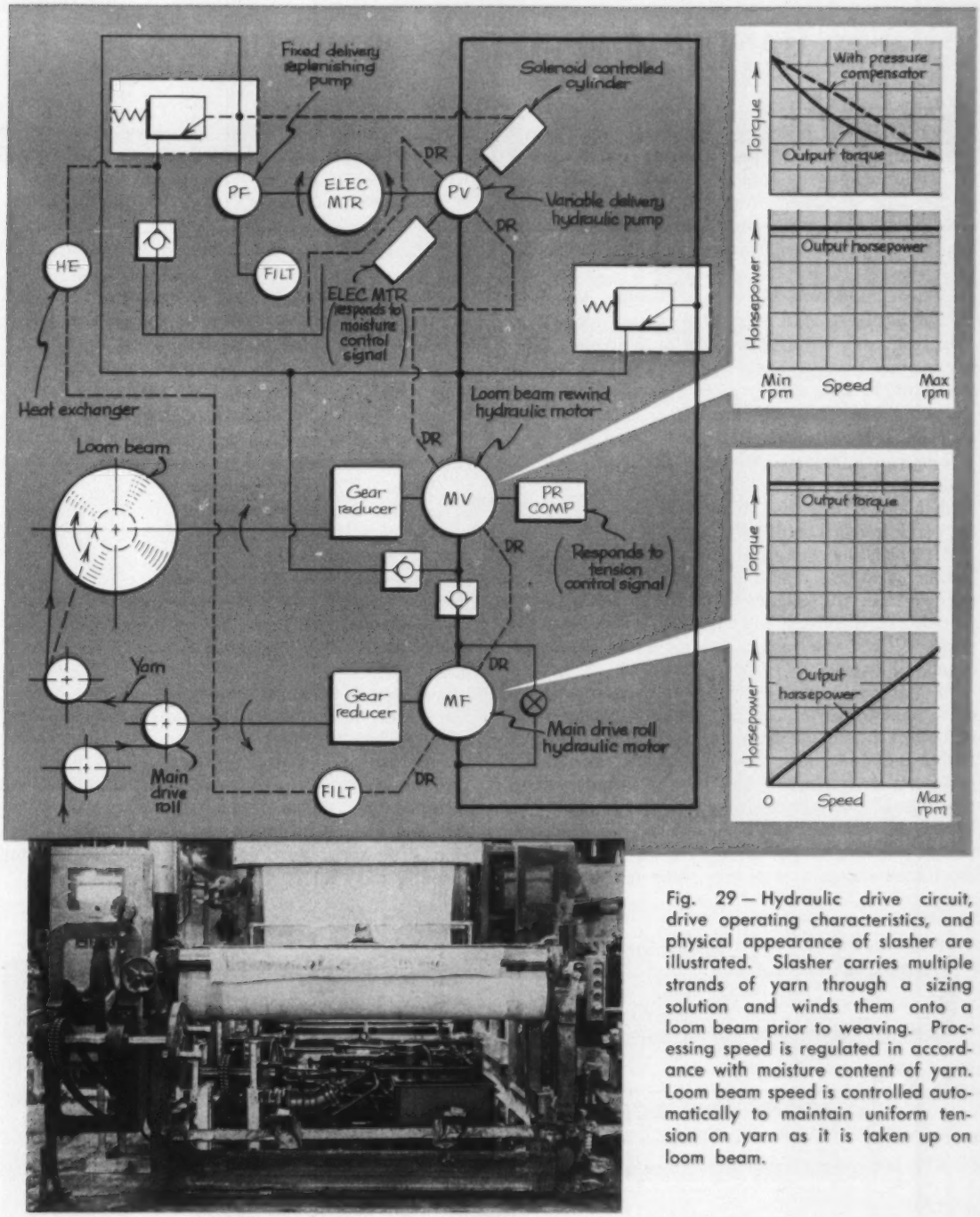


Fig. 29 — Hydraulic drive circuit, drive operating characteristics, and physical appearance of slasher are illustrated. Slasher carries multiple strands of yarn through a sizing solution and winds them onto a loom beam prior to weaving. Processing speed is regulated in accordance with moisture content of yarn. Loom beam speed is controlled automatically to maintain uniform tension on yarn as it is taken up on loom beam.

motion to an easily controllable, variable speed rotary motion which can be readily adjusted over a range of speeds. A simple constant speed prime mover used in combination with a hydraulic drive produces an adjustable speed drive that can provide high starting torque, with heavy or light loads, without the danger of overloading the prime mover. The many inherent advantages of adjustable speed hydraulic drives, plus their demonstrated service reliability over many years, suggest their applicability to a variety of industrial processes.

Part 4, the concluding article in this series, will appear in a succeeding issue. This article will cover applications of electrohydraulic servo systems to automatic production equipment. Basic circuits, major control functions, and operating characteristics will be described in terms of practical, working arrangements.

HANDLING BUMPERS FOR PLATING

MODERN handling equipment has helped maintain quality and increase production of chrome plated automobile bumpers at the Automotive Div. of Rheem Mfg. Co. An automatically controlled, overhead monorail system facilitates movement of parts carriers between units in the multistep process. The plating facility, which provides a total of 54 process baths, was designed and built by Udylite Corp. and subsidiary L. H. Butcher Co.

In operation, tractors powered by individual electric motors move around the monorail system at speeds of 50 fpm. At periodic "block" points, the tractors actuate limit switches. If a particular block is occupied by a tractor, the next succeeding tractor will activate a limit switch and stop one block behind. When the tractor in the forward block passes a point farther down the line, it activates a switch that starts the tractor behind it.

At a loading point, bumpers delivered from a forming area are placed manually on carriers suspended from the tractors. Ten to 16 bumpers are placed on each carrier, depending upon the size of the product. Then, the tractor is started on its way by operation of a switch.

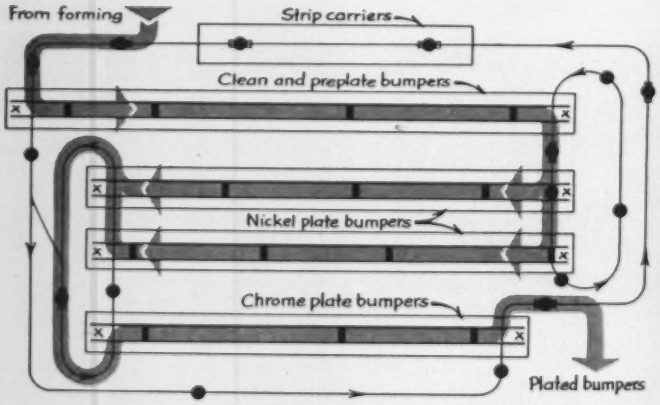
As a tractor carrying a load of bumpers proceeds on a main conveyor loop, it reaches a transfer point and stops automatically. A section of the monorail supporting the tractor then lowers and the carrier and parts are transferred to a device that moves them through a Udylite cleaning and preplating line. When this transfer has been effected, the monorail section and tractor are raised back into position and the tractor moves to a pickup point at the end of a chrome plating line. There, it picks up a carrier loaded with plated parts and carries them to a point where the bumpers are unloaded and inspected.

The tractor and empty carrier then proceed on the main monorail and move through an electrolytic strip tank. Here, excess chromium is removed from the carriers to prevent later contamination of the solutions in the cleaning and preplating line. Finally, the tractor and carrier return on the main monorail to the starting point where they are loaded.

Carriers that have been transferred to the cleaning and preplating line are indexed automatically through this unit by hydraulically operated pushers. As they stop at various points along the line, the carriers are lowered into processing tanks and lifted in unison. The time spent by the bumpers in the preplating tanks is controlled precisely, since the quality of subsequent plating applications depends strongly upon this factor.

At the end of the cleaning and preplating process, the carriers and parts arrive at a transfer point in a secondary conveyor loop. There, the loaded carriers are picked up by tractors and moved to transfer points above the first tanks in either of two parallel nickel plating lines. Operators advance the carriers and lower them into tanks by means of hoists on an overhead conveyor.

After nickel plating, the carriers and parts are transferred to tractors on another conveyor loop and delivered to a chrome plating line. At the end of this line, they are picked up by the tractors that previously delivered loads of unplated bumpers to the cleaning and preplating line.



LEGEND
- ● – Monorail tractor
- ▭ – Parts carrier (empty)
- ▬ – Parts carrier (loaded)
- ⊣×⊢ – Transfer point

Schematic plan view of conveyorized plating installation illustrates flow paths for loaded and unloaded automobile bumper carriers and monorail tractors. Bumpers are prepared and plated with nickel and chromium in processing units. Photo shows transfer point where section of monorail is lowered to transfer loaded carriers from tractors to indexing device at beginning of cleaning line. Carriers are then advanced and dipped automatically in multiple processing tanks. Tractor on curved section of monorail, right, has transferred a carrier to cleaning line and is proceeding on conveyor to pick up a carrier containing chrome plated bumpers and deliver products to an unloading point. When empty, carrier is returned by tractor to bumper loading point on main conveyor.

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automatic curtain rolls away paint overspray

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It's economical . . . a roll costs less than 2 cents per square foot...about 80% less than most paint filters cost.

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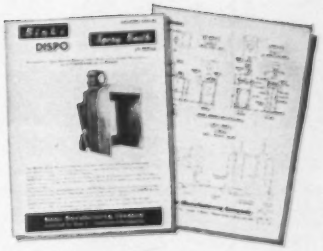

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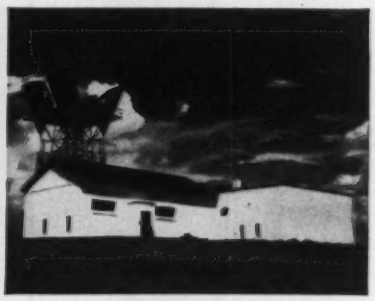
What was Bell Telephone Laboratories doing

ON FRIDAY, JUNE 30, 1961?

It was exploring the communications possibilities of the gaseous optical maser – a device which generates continuous coherent infrared radiation in a narrow beam.

It was preparing an experiment in world-wide communications using "active" satellites powered by the solar battery, a Bell Laboratories invention.



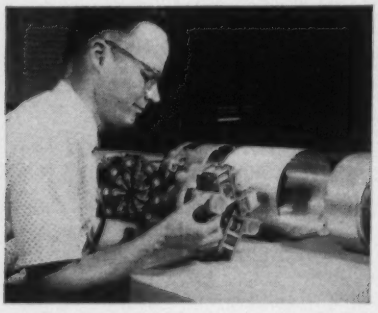
It was completing the development of a new "heavy route" Long Distance microwave system capable of handling over 11,000 two-way conversations at once.

It was developing an anti-missile defense system designed to detect, track, intercept and destroy an enemy ICBM – in a matter of minutes.

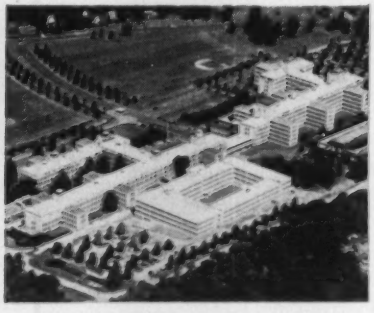
It was demonstrating the potentialities of the superconducting compound of niobium and tin for generating, with little power, magnetic fields of great strength.

It was experimenting with an electronic central office at Morris, Ill., which is capable of providing a wide range of new telephone services.

It was perfecting the card dialer which permits, through insertion of a punched card into a slot, automatic dialing of frequently used numbers.



It was developing improved repeaters or "amplifiers" to increase greatly the capacity and economy of undersea telephone cable systems.



It was continuing its endless search for new knowledge under the leadership of scientists and engineers with world-wide reputations in their chosen fields.

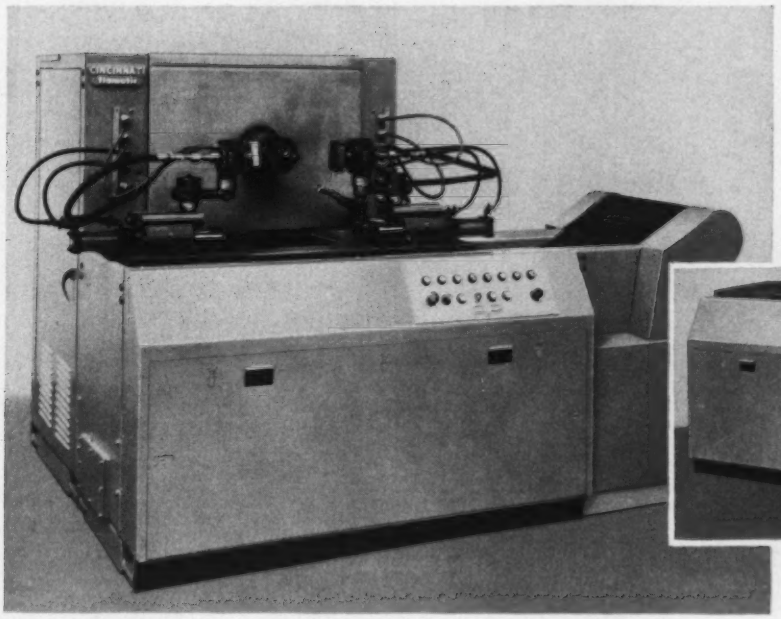
Bell Laboratories scientists and engineers work with every art and science that can benefit communications. Their inquiries range from the ocean floor to outer space, from atomic physics to the design of new telephone sets, from the tiny transistor to massive transcontinental radio systems. The goal is constant—ever-improving Bell System communications services.

BELL TELEPHONE LABORATORIES

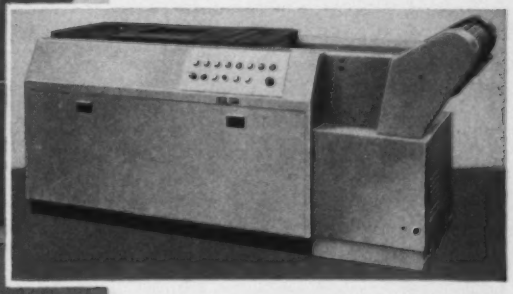
World center of communications research and development

AUTOMATION new equipment

Machines and plant equipment for more automatic operations.
For detailed information and literature, use card page 35.



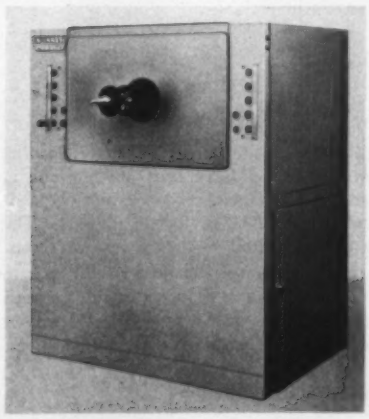
Flame hardening machine, designated Flamatic, is built up from a building block system which permits specific machines to be assembled from a wide variety of standard, interchangeable units. It incorporates a rotary, retractable work spindle, control of fuel gas, oxygen, air, water, and primary electric power for safe, precise operation with low maintenance.



Conveyor-type quench tank is completely self-contained and includes automatic agitation and circulation of the quench medium, a heat exchanger, and a motor driven conveyor to remove parts from the quenching medium.

Flame Heating Machine

DEVELOPED by **Meta Dynamics Div., Cincinnati Milling Machine Co.**, Cincinnati 9, Ohio, this flame heating machine is assembled from standard building block units. This design permits selection from a wide variety of standard units, in varying combinations, to provide machines with specifically desired characteristics. The machine provides rapid, selective flame heat processing for a variety of heating applications. It consists of a self-contained No. 1 Flamatic flame heating unit, with the necessary retractable, rotating work spindle, and standard flame heads, combined with a self-contained quench tank. The quench tanks are designed in two styles, basket-type and conveyor-type, to meet various production needs. They have fixed table height. Tee-slotted workplates provide rigid support and positive alignment for a wide variety of work-holding devices, flame heads, etc. The flame heating unit incorporates precise control of fuel gas, oxygen, air, water, and primary electric power. Temperature hardening range is from 800 to 1800 F. Infinitely variable spindle speeds range from 15 to 375 rpm. Work spindle retraction is 10 inches. Available accessory equipment includes such items as electronic temperature control, rotary flame head, and a wide variety of work-holding and automatic work-handling fixtures.



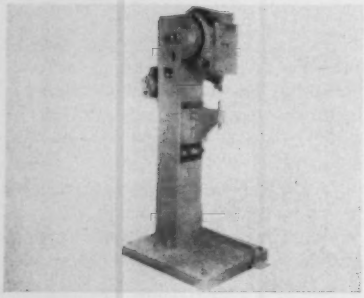
Flame heating unit is shown with a rotary, retractable work spindle. A wide range of work-handling fixtures is available to adapt it to automatic heat processing operations of all kinds.

Circle 401 on page 35

DATA COLLECTION UNIT ELIMINATES NEED FOR MANUAL TRANSCRIPTION

Machine, designated Stanrecorder, provides for accurate recording of employee activities and the automatic entry of such data into machine accounting systems. Data input is by embossed plates, time clocks, prepunched cards, and keyboards. Information is recorded on man readable forms and machine readable forms. Both forms can be refolded into a locked compartment in the machine or one copy can refold while the other may be torn off. The machine can be furnished with a production counting device. Capable of holding 3000 forms in operating position at all times, it also has storage space for another 3000. Reader-translator equipment converts the information into proper input language for other machine or computer use. Standard Register Co., Dayton 1, Ohio.

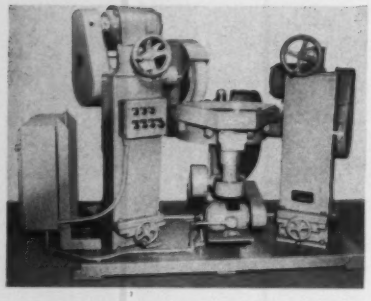
Circle 402 on Page 35



RIVETING MACHINE FOR LARGE SEMITUBULAR RIVETS

Heavy-duty riveting machine has been designed to automatically feed and set semitubular rivets up to ⅜ inch in diameter and 17/16 inch long, with a heavy setting as required by the automotive industry. It features an eccentric drive toggle linkage attached directly to the spindle. This mechanism enables the machine to develop a force of 5 tons through the rivet setting range of 20 per cent reduction of flywheel energy. Standard throat depth of TRS Model 115J is 10 inches, but depths of 12, 14, or 16 inches can be obtained. Many interchangeable brackets and posts may be selected to meet unusual clearance requirements. The riveter can be equipped with hydraulic power if desired. Tubular Rivet & Stud Co., Quincy 70, Mass.

Circle 403 on Page 35



SPECIAL MACHINE CHAMFERS HELICAL SPRINGS

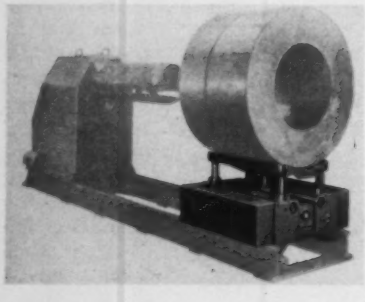
Machine automatically chamfers the top and bottom edges of helical steel springs at a rate to 2000 to 4000 springs per hour with manual loading techniques and 7000 to 8000 per hour with an automatic hopper feed arrangement. The unit consists of a rotating friction drive work fixture and two adjustable grinding lathes mounted on a common base. The drive consists of a rubber faced rotor that continuously contacts the periphery of the springs, and a V-belt that contacts the periphery of the springs only in the two chamfering stations. The faces of both grinding wheels are contoured to the machine radius. The machine illustrated chamfers 13/16-inch diameter, 1⅛-inch long helical steel springs at a production rate of 3000 per hour. Acme Manufacturing Co., 1400 E. Nine Mile Rd., Detroit 20, Mich.

Circle 404 on Page 35

LEAK DETECTOR DESIGNED FOR HIGH EFFICIENCY PRODUCTION-LINE TESTING

Capable of testing hermetically sealed components for leaks in the 10^{-11} atm cc/sec range, Type 24-510 Radiflo leak detector has a large capacity and short activation period. It can be adjusted to automatically process a wide variety of devices such as transistors, diodes, crystals, and ordnance devices. Depending upon component size, up to 10,000 transistors can be tested in a single activation cycle of less than an hour. Testing is completed in two stages—activation and inspection. During activation components are exposed to radioactive tracer gas under pressure. Either Go-No-Go or quantitative inspection can be performed on individual components with a scintillation counter which measures the radiation level. Consolidated Electrodynamics Corp., Subsidiary, Bell & Howell Co., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 405 on Page 35



COIL LOADING CAR LIFTS 10-TON COIL 18 INCHES

By keeping a reserve coil next to the reel, ready for use, Model S-200 coil loading car eliminates production delays that occur when one coil is depleted and a crane to bring up a new coil is not immediately available. Its automatic, electronically controlled operation makes it easy for one man to load a 20,000 lb coil on the reel. The car raises the coil to proper height, moves the coil forward and onto the reel's contracted expansion arms, lowers from contact with the mounted coil and moves back to position to receive a new coil. Widths of rails, or flange to flange distance between wheels is 32½ inches. Tracks must be at least 10 inches high for cylinder clearance. F. J. Littell Machine Co., Service Dept., 4101 N. Ravenswood Ave., Chicago 13, Ill.

Circle 406 on Page 35

So gentle it won't chip china, yet powerful enough to bend steel tubing as if it were a soda straw. In a nutshell, this demonstrates the almost unbelievable degree of control built into Logan air-draulic devices.

The controlled accuracy gives this equipment a versatility and flexibility that makes it adaptable to all kinds of jobs, ranging from precision laboratory assignments to actual production line work.

If you would like additional information about air-draulic devices or other Logan products, merely fill in the coupon below.

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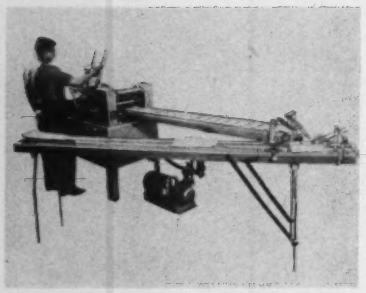
Circle 687 on Page 35



ROTARY PRESS FEATURES RETURN EXTENSION DELIVERY SYSTEM

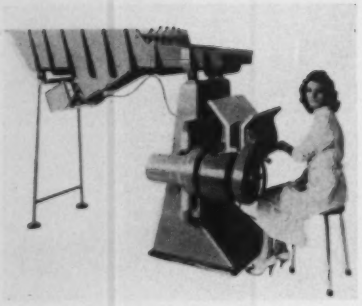
High-speed rotary printing press, the JP-1, utilizes an unusual oscillatory vacuum feed for speeds up to 30,000 iph. It is designed for printing of letters, tabulating cards, office and factory forms, closed and open end envelopes, labels, tickets, and tags. Feature of the press is a return extension delivery system (Mark III REDS) which brings the printed material back to the feeder. This feature eliminates one operator, keeps offsetting to a minimum and also eliminates backing jams and pileup in delivery. Machine handles sheet stock ranging in size from 3 by 5 to 8½ by 11 inches. It operates at speeds in excess of 45,000 impressions per hour using one rubber printing plate on the impression cylinder. **Halm Industries Co. Inc.**, Glen Head Rd., Glen Head, Long Island, N. Y.

Circle 407 on Page 35

LIVE ROLLER CONVEYOR HANDLES WIDE RANGE OF UNITS

Low pressure, live roller conveyor has been developed to simplify problems associated with accumulation of cartons and crushable commodities on live rollers. Even badly staggered commodities can be accumulated under pressure on the conveyor without jackknifing. The pressure exerted on accumuated commodities is 3½ per cent of commodity weight. This conveyor will handle units with a wide range of mixed sizes and weights. It is available in the following widths: 10½, 14½, 16½, 20½, 26½, 32½, and 38½ inches. Conveyor is now being used to convey and accumulate phonograph records, packed meat products, wholesale drug items, and packaged paper products. **Standard Conveyor Co.**, North St. Paul 9, Minn.

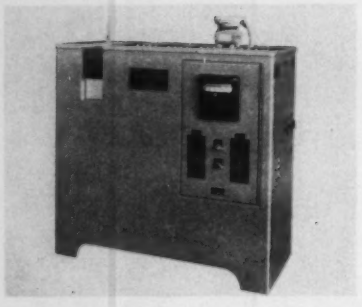
Circle 408 on Page 35



ELECTROMAGNETIC NAIL AND BOLT PACKING MACHINE

Electromagnetic nail and bolt packing machine can be used for many secondary operations such as aligning bolts, nails or straight wires for easy packing and for packing finished or partly processed items for stock or storage. Parts from 1 to 10 inches are instantly aligned and stacked. The machine consists of two main parts, a frame with an electromagnetic adjusting apparatus and on it a hopper with a vibrator. This machine is adjustable to height of operator and to speed flow. Change of length is made by simple adjustment of channels and pole faces by a hand wheel. Among the features of the Nail-Pac 57 are uniformity of pack and cleanliness of cartons. **Imported Machinery Sales Co.**, P. O. Box 148, Berea, Ohio.

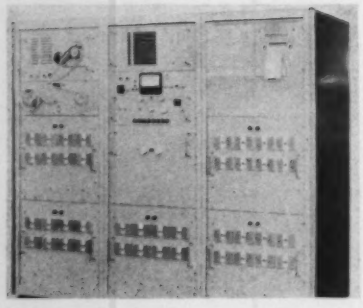
Circle 409 on Page 35



RECIPROCATING FURNACE FOR BRIGHT HARDENING OF SMALL PARTS

Featuring pushbutton control for clean, automatic, and rapid operation, Model FLA-12 reciprocating furnace is designed for low cost/high volume bright hardening of very small, slender, or fine parts. Watch parts, ball bearings, and instrument, photographic, and equivalent components are examples of the parts processed. Unitized design of the furnace includes controls for exact time-temperature cycling plus easy-access panels for servicing. Hydrogen, dissociated ammonia, endothermic and other protective atmospheres may be used. **C. I. Hayes Inc.**, 808 Wellington Ave., Cranston 10, R. I.

Circle 410 on Page 35



TAPE-PROGRAMMED CABLE HARNESS ANALYZER

Model 230 automatic cable tester features programmed continuity, leakage from wire under test to all other wires, complete random selection, 100 per cent branch testing capabilities, and fault printout. Search scan feature permits rapid location of all existing faults by holding one end of the wire under test, while scanning all others. Analyzer offers complete random selection of both standard and branch circuits. Continuity is 1 to 15 ohms in 1 ohm steps, and 10 to 150 ohms in 10 ohm steps. Leakage is 10 to 100 megohms in 20 megohm steps, and 100 to 500 in 100 megohm steps. Search scan rate is maximum of 10 seconds per switching unit. **California Technical Industries, Div., Textron Inc.**, 1421 Old County Rd., Belmont, Calif.

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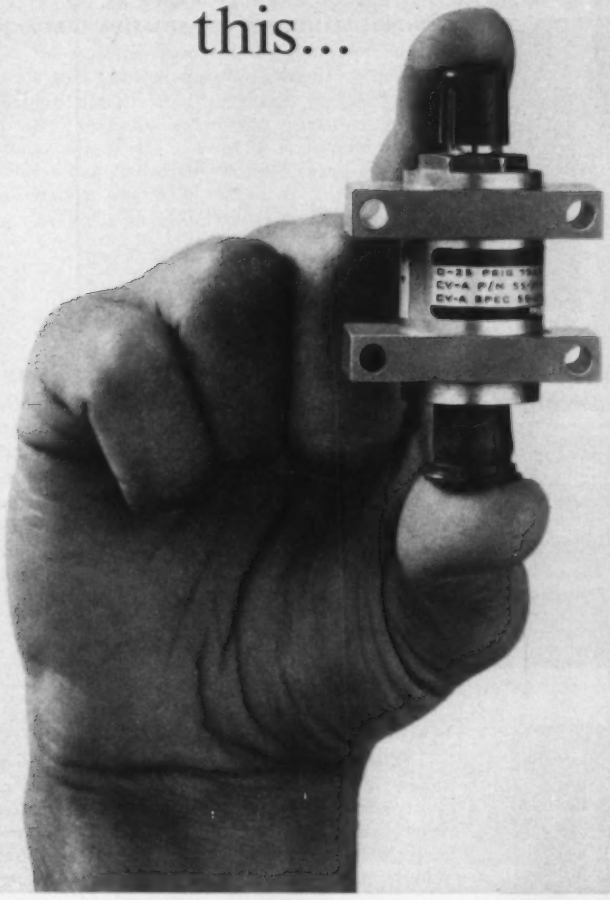
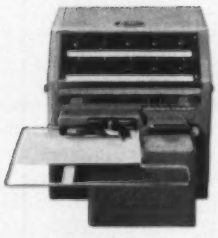
How Convair-Astronautics keeps track of this...



(and 84,999 other missile parts)



The Manufacturing Control Department at Convair (Astronautics) Division of General Dynamics Corporation has a monumental problem: how to keep track of the movement of over 85,000 individual missile parts.

The solution: *automated data preparation* by means of a Friden Collectadata® system. Situated in key plant locations, Collectadata transmitters report virtually all parts movements—over 5000 every day—to central Collectadata receivers which record them into punched paper tape. At day's end the Collectadata tapes are fed into the electronic computer at Astronautics for further data processing.

This is what Astronautics says: *"The Collectadata has been in use at Astronautics for less than a year. But by eliminating tedious manual paperwork, and by assuring prompt processing of all inventory reports, it has already saved considerable time, trouble and money."*

How much could Collectadata save you? Call your Friden Systems Man, or write: Friden, Inc., San Leandro, Calif.

THIS IS PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it.

Sales, Service and Instruction Throughout the U. S. and World

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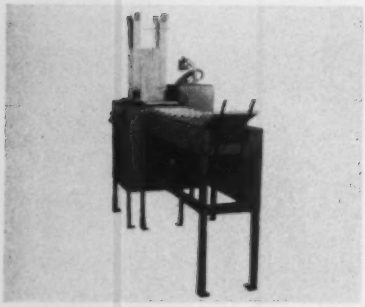
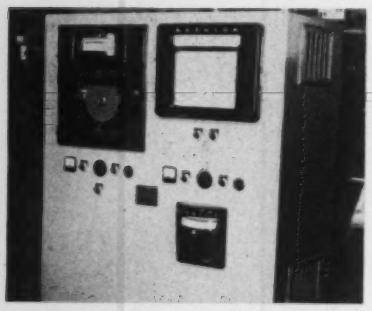


BOX MARKING MACHINE IMPRINTS LIDS ON ASSEMBLED BOXES

Automatic box marking machine, designated Model 152A, imprints the lid ends of filled or empty assembled boxes. As many as 65 boxes per minute can be printed. The machine controls the registration and alignment of the imprint so that the boxes present a neat and attractive appearance when stacked. It will print boxes from 6 to 8 inches long, 4 to 8¼ inches wide, and from ⅜ to 1⅝ inches thick with a maximum imprint area of 1⅝ by 6¾ inches. Suitable for short runs as well as volume production, this machine can be changed over to run a different box size in minutes. Part or all of the imprint can be changed in seconds. **Markem Machine Co.**, 176 Congress St., Keene, N. H.

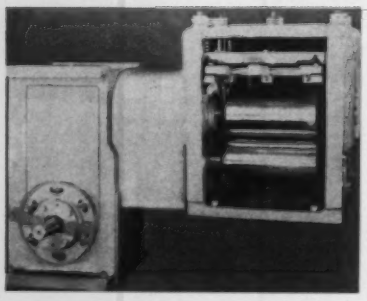
Circle 412 on Page 35



CONTROL CENTER FOR COMBINATION LABORATORY AND PRODUCTION CONTROL

Control equipment has been developed for use with various single and two zone tubular type electrical furnaces involved in a semiconductor program. In some phases of the program, indicating proportioning control is required. In other operations, program proportional control is necessary. The recording of the operating temperatures is required at all times. The control center incorporates an 8000 Series multipoint recorder, a Model 407 Capacitrol, and a Model 72000-S259 Chronotrol along with the necessary magnetic amplifiers and saturable reactors. **Wheelco Industrial Instruments Div., Barber-Colman Co.**, Rockford, Ill.

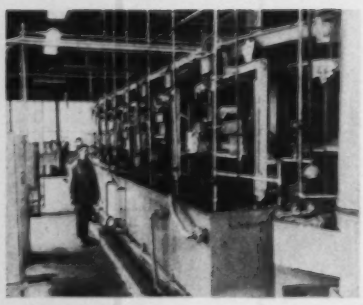
Circle 413 on Page 35



ROLL FEED EXCEEDS 1000 PRECISION STROKES A MINUTE

This mechanism incorporates a new approach to roll and strip feeding of stock that combines dynamically controlled stock with the inherent accuracy of roller gear drive indexing to achieve precision feeding at rates over 3000 inches a minute. A standard Camtrol roll feed unit consists of a roll assembly with hardened rolls, ground with absolute concentricity and supported by permanently lubricated antifriction bearings, coupled to the cam indexing mechanism. The roll assembly is self-adjusting for variations in stock thickness. Strokes up to 6 inches are available with a standard roll feed. Others can be provided with modifications of the design. **Ferguson Machine Co.**, 7818 Maplewood Industrial Court, St. Louis 17, Mo.

Circle 414 on Page 35



PLATING MACHINE FEATURES CENTRAL CONTROL PANEL

Variable, integrated, plating machine has a central control panel from which a variety of transfers, delayed dips, barrel rotations, dwell periods, and power can be programmed to meet most plating requirements. Each barrel and carriage assembly containing parts that are being plated may be controlled separately. The machine has a multiple indexing system that permits the central control panel to program barrels through the processing and plating tanks at different rates of speed, keeping the plating tank full at all times. This feature eliminates the necessity of having a barrel at every station of the machine. **Udylite Corp.**, Detroit 11, Mich.

Circle 415 on Page 35

TRANSISTOR PARAMETER TEST MACHINE

Designated the Virtue-201, this machine has been designed in accordance with advanced computer techniques providing many specific safety features to minimize the possibility of human error during testing and to preclude the printout of incorrect data resulting from equipment malfunction. Foolproof programming is achieved by use of a program card containing type identification, voltage levels, circuit constants, maximum-minimum parameter limits, and selected circuit tests. Final punched-card information is delivered in the form of a unit record. Machine can test 8 transistor parameters and record the findings on punch cards in 12.5 seconds. Approximately 275 transistors can be tested per hour. **Lansdale Div., Philco Corp.**, Lansdale Pa.

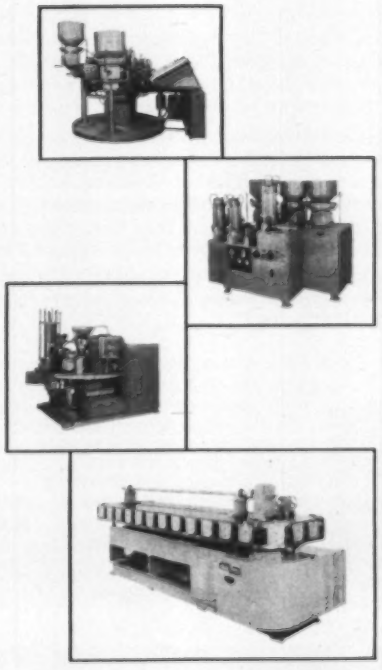
Circle 416 on Page 35

For companies who use, or plan to use...

AUTOMATIC ASSEMBLY EQUIPMENT

Swanson-Erie Corporation offers a capable, imaginative and experienced source for automatic assembly and processing equipment. Over the past 20 years we have devoted our activities almost exclusively to the design and manufacture of highly efficient machines for the production of a host of consumer and industrial products.

We are in a position to best serve those companies who require top quality dependable complex equipment to produce in large volume with a high degree of mechanical reliability.



Swanson-Erie capabilities encompass a wide variety of products and services which include: *standardized indexing machine chassis in many types and sizes; the manufacture of special machines to customers' designs; an integrated service which encompasses the complete functional responsibility for special machine projects from design to final testing and development; the manufacture of proprietary machines for the high speed production of incandescent and fluorescent lamps, radio tubes, glass and electronic components.*

All are built to the most exacting standards of quality and reliability. All carry a guarantee of complete parts interchangeability. We welcome the opportunity to personally discuss special machine projects with firms seriously considering the use of automatic production equipment. And, we will be pleased to submit a proposal on those projects which fit within our scope of activity.

A booklet of our products and facilities is available on request.

SWANSON-ERIE CORPORATION

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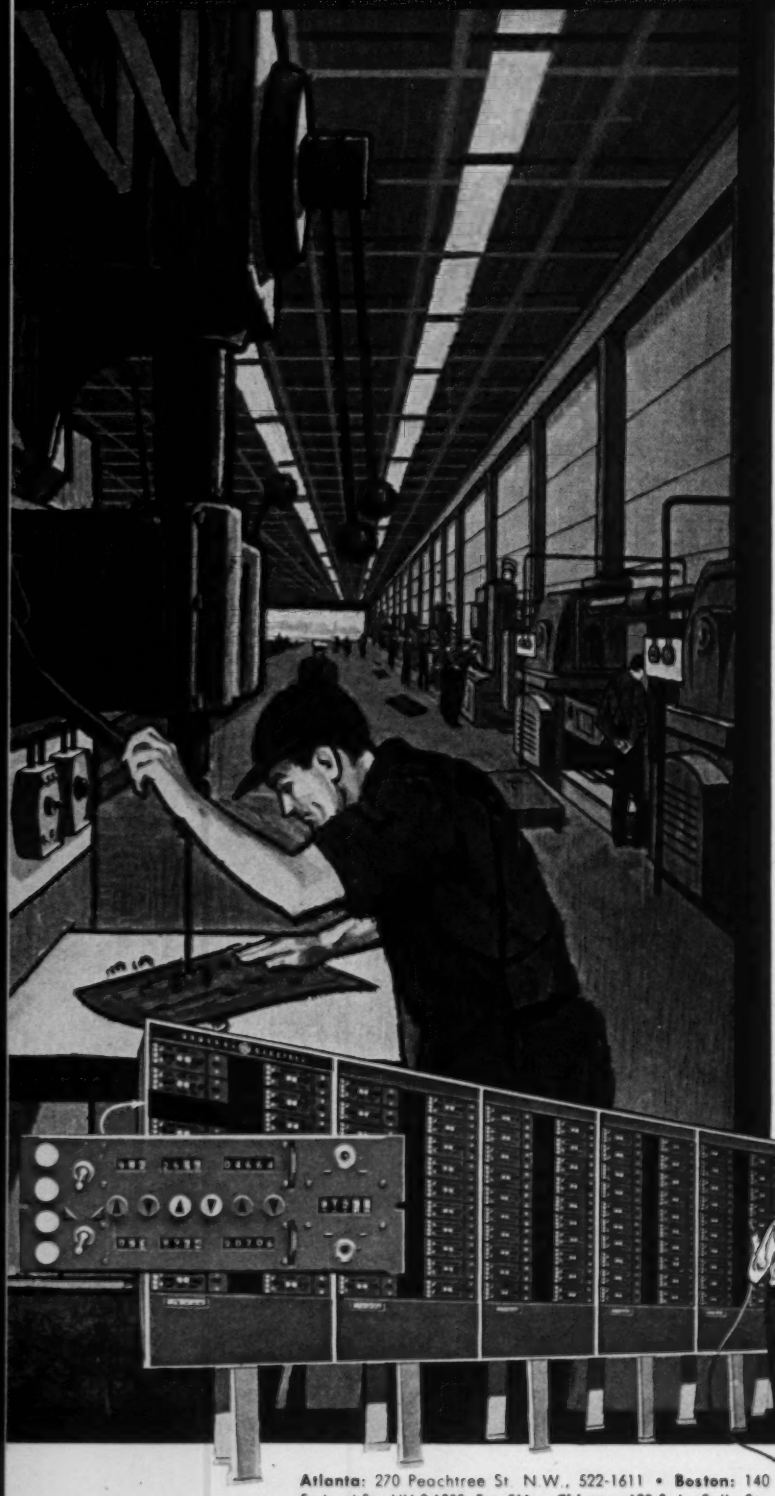
Creators of... Better Automatic Machines For Less Cost In Less Time

Circle 689 on Page 35

ONE OF THESE NEW GE MANAGEMENT CONTROL



New GENERAL ELECTRIC SHOPTROL *System monitors individual work stations...displays production status at a control center for timely reactions to factory conditions.*

The GE SHOPTROL SYSTEM is a factory monitoring and data collection system that monitors work stations and records production data at a central point. Each work station's status is visually displayed on a Status Monitor. Status Monitors present a panoramic view of up-to-the-minute factory conditions for visual display at the Production Control Center. Work stations have an operator control station, or an alarm station terminating at the Control Center. Depending on complexity of communication needed and data to be transmitted, a paging selector may be added to each work station.

The Shoptrol System records, in hundredths of hours, time elapsed for operations, set-up and tear down, unavoidable delays, machine running, and machine off conditions. The Shoptrol System can record time elapsed, or count pieces or operations.

The Shoptrol System provides direct signal communications from work stations to the Production Control Center. The operator control station and paging selector have phone jacks to provide entry into the telephone intercom. Units are ruggedly built for dependable life in factory conditions.

Totals recorded from the Status Monitors at the end of shift produce information for production control analysis and management decision making. The data is readily convertible to punched cards or paper tape for input to a data processing system. For more information, write for brochure CPB-152, General Electric Company, Computer Department, Section 90M8, Phoenix, Arizona, or your District Office listed below.

THE GE SHOPTROL SYSTEM CONTRIBUTES TO GREATER PRODUCTION EFFICIENCY BY:

...providing constant communication between production control center, foreman, and work station operators.
...collecting and displaying current production data for each work station.
...increasing accuracy of production records.
...providing immediate production status for management at all times.

Atlanta: 270 Peachtree St. N.W., 522-1611 • **Boston:** 140 Federal St., HU 2-1800, Ext. 311 • **Chicago:** 120 S. La Salle St., 782-5061 • **Cleveland:** 215 Euclid Ave., SU 1-6822 • **Dallas:** 3200 Maple Ave., RI 8-0589 • **Detroit:** 680 Antoinette St., TR 2-2600 • **Houston:** 4219 Richmond Ave., MO 7-3301 • **Kansas City, Mo.:** 106 W. 14th St., GR 1-2919 • **Los Angeles:** 1010 S. Flower St., DU 1-3641 • **Louisville:** Bldg. 6, Appliance Pk., GL 4-7511 • **Minneapolis:** Plymouth Bldg., 6th & Hennepin, FE 2-7569 • **New York:** 122 E. 42nd St., PL 1-1311, Ext. 3205 • **Philadelphia:** 3 Penn Center Plaza, LO 8-1800 • **Phoenix:** Guaranty Bank Bldg., 3550 N. Central Ave., AM 4-3741-2 • **Pittsburgh:** 1634 Oliver Bldg., Mellon Sq., AT 1-6400, Ext. 566 • **San Francisco:** The Russ Bldg., 235 Montgomery St., DO 2-3740 • **Schenectady:** Bldg. 2, 1 River Rd., FR 4-2211, Ext. 5-4405 • **Seattle:** Dexter Horton Bldg., 710 Second Ave., MA 4-8300 • **St. Louis:** Paul Brown Bldg., 818 Olive St., GE 6-4343 • **Syracuse:** 1010 James St., GR 6-4411, Ext. 6141 or 6142 • **Washington, D.C. Area:** 7401 Wisconsin Ave., Suite 514, Bethesda, Md., OL 2-8100.

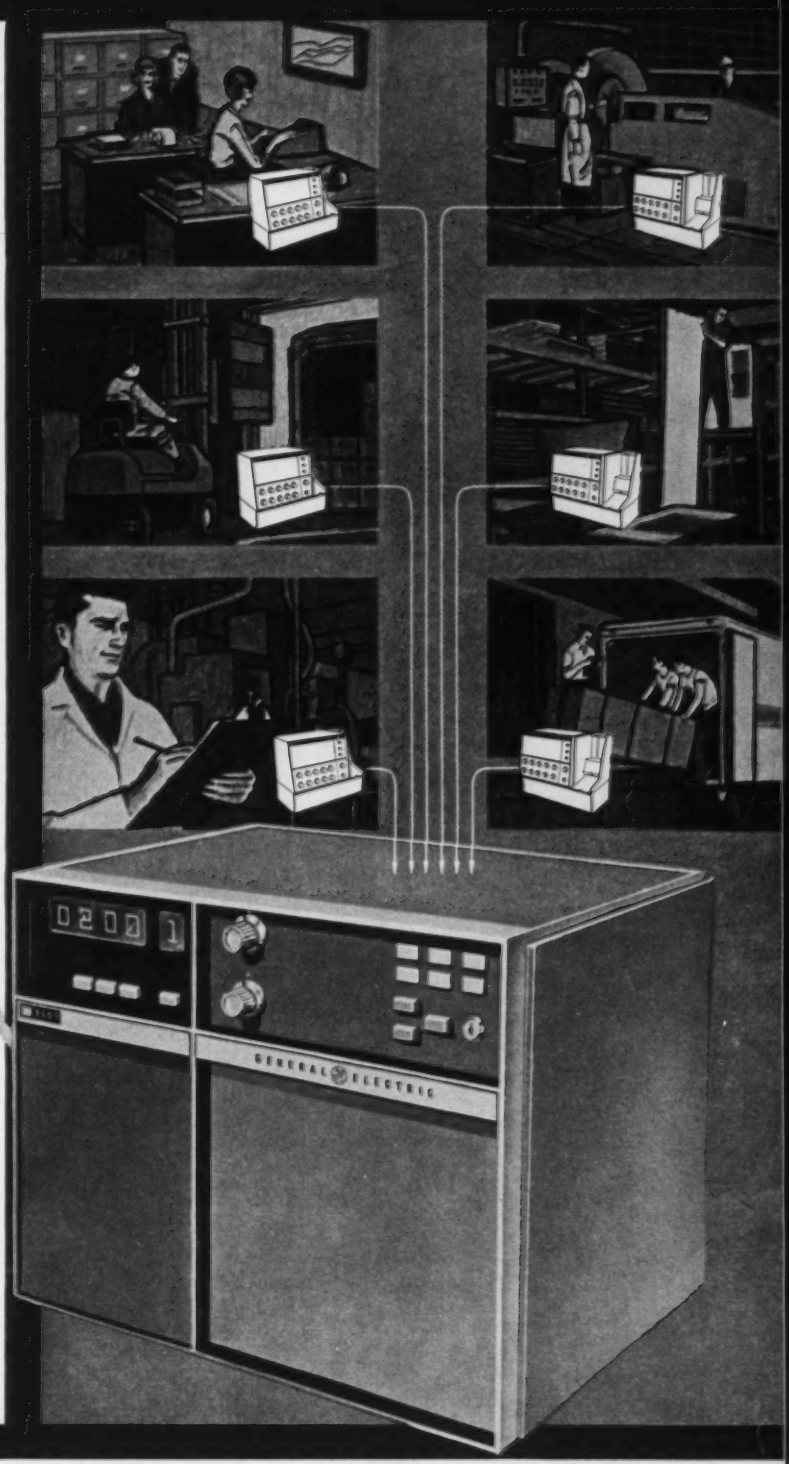
SYSTEMS WILL SAVE YOU MONEY THIS YEAR

New GE 3101 DATA ACCUMULATION and COMMUNICATION *System provides immediate plant/office data communication...as a management tool to increase production and reduce costs.*

The GE 3101 is General Electric's answer to the need for an economical and effective means of collecting operational data. Key areas such as purchasing, receiving, quality control, shop operations, warehouse, shipping, etc., send current data to a central point for collection and display. Each of the key areas has a Collector that sends data to the Accumulator, where it is punched into paper tape for a permanent record. Data originating at the Collector is from punched cards and/or 19 variable dial settings. Collectors may be up to 10,000 feet from the Accumulator.

The punched paper tape can produce a typewritten copy immediately for visual display of current conditions; can be converted to punched cards; or can be used for direct input to a computer system. Investigate this new, lower cost development by General Electric.

Installation of the GE 3101 information gathering system can result in greater operational profits due to: accuracy and timeliness of data, economy of operation, and quicker access to the facts for well informed decisions by management.



For more information, write General Electric Company, Computer Department, Section 90M8, Phoenix, Arizona, or contact your nearest General Electric Computer Department District Office listed below.

In Canada: Canadian General Electric Co., Ltd., Electronic Equipment and Tube Dept., 830 Lansdowne Ave., Toronto, Ontario, Canada. **Outside U.S.A. and Canada:** Producer Goods Export Department, International General Electric Company Division, 150 East 42nd Street, New York City, N.Y., U.S.A.

INFORMATION PROCESSING AUTOMATED BY GENERAL ELECTRIC

Progress Is Our Most Important Product

GENERAL ELECTRIC

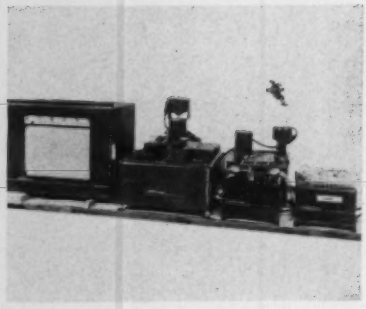
CPA 90 (7-61)

Circle 690 on Page 35

AUTOMATIC MILLING MACHINE HAS SELF-CONTAINED MILLING HEAD

This precision machine is designed to continuously move a wide range of parts beneath a milling cutter to achieve production rates of 250 to 3000 completed parts per hour. A matched set of holding bases are hardened and ground, accurate to ±0.00025 inch, allowing parts to be held within tolerances of ±0.001 inch. A heavy duty precision spindle with horizontal and vertical micrometer adjustments, becomes an integral part of the AutomaticMill to achieve a compact high production milling machine. The basic machine can also be clamped to the bed of a horizontal or vertical milling machine or to the table surface of a grinder. It is ideal for long production runs of several hundred thousand parts. **AutomaticMill Inc.**, Danbury Industrial Park, Danbury, Conn.

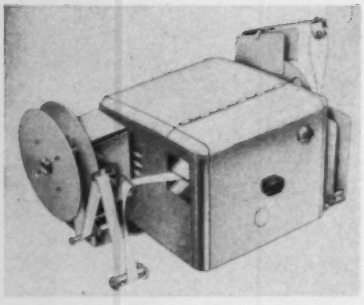
Circle 417 on Page 35



CHEMICAL ANALYZER FOR ON-STREAM MONITORING

Differential AutoAnalyzer for continuous chemical analysis, with automatic blank or interference compensation, can detect trace materials down to parts per billion with an accuracy of 1 per cent. It automates all steps of a chemical analysis and integrates them into a continuous flow system. The instrument system automatically measures, mixes, purifies, processes, compares and records, and runs 20, 40, or 60 complete tests without human supervision. It is available for single or multiple component determinations, for laboratory, or plant use. Selenium photocells are used for 400-650 mu. wavelength range. For wavelengths between 600-950 mu., silicon photocells are employed. **Technicon Controls Inc.**, Research Park, Chauncey, N. Y.

Circle 418 on Page 35



PARALLEL-WIRE TAPE PUNCH RECORDS DATA INTO MASTER TAPE

Designed to receive parallel-wire input from message communications equipment, Model 28 LARP off-line tape punch set can serve as a slave unit in a wide range of data and message communications systems. It is electromechanically operated, and provides programmed storage in fully perforated tape. In data collection systems, it records information gathered from many sources into one "combination" master tape that can be used in communications systems. When attached to business machines, such as calculators, the unit yields a record by-product tape. Operating at 20 characters per second, this tape punch is available for 5, 6, 7, or 8 level operation. **Teletype Corp.**, Dept. SP-14, 5555 Touhy Ave., Skokie, Ill.

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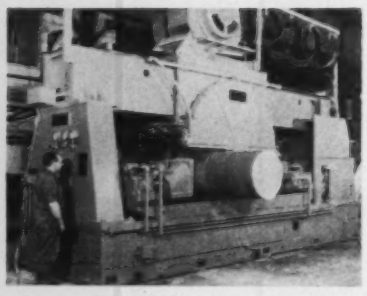

CIRCULAR SAW CUTS ALUMINUM BILLETS AND SLABS

Hydraulically operated high-speed circular saw is designed to cut billets up to 36 inches in diameter and slabs up to 20 inches thick by 80 inches wide. It can be equipped with up to 100-inch diameter blades, and is driven by a 200 hp two-speed motor to operate at 300 or 6000 ft per minute cutting speeds, depending on the alloy being handled. Feature of the machine is its overhead sliding carriage design that results in all essential moving parts of the equipment being located above the saw table. This saw is equipped with oil-hydraulic feed providing cutting rates infinitely adjustable up to 2 inches per second and return rates up to 3 inches per second. The saw is equipped with a safety feature that makes it virtually jam-proof. **Loma Machine Mfg. Co. Inc.**, 114 E. 32nd St., New York 16, N. Y.

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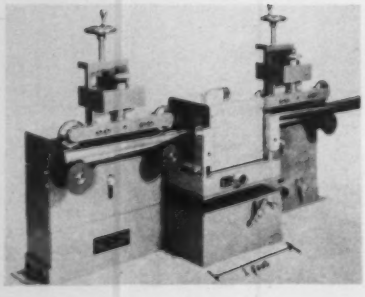

AUTOMATIC EDDY CURRENT TESTING OF ROUND TUBING AND BAR STOCK

These two tubing and bar stock feeders are designed primarily to work in conjunction with eddy current tests. The through-coil test equipment automatically locates defects in ferrous or nonferrous products such as rod, wire, and seamless or welded tubing and pipe. Constant speed, minimum deviation from the centerline of the coil, and easy access to the coils for rapid size changeover are features of the feeders. Model X-2316 (illustrated) handles diameters in a range from ¼ inch to 4 inches. Its variable speed drive, working through V-pulleys, offers speeds from 40 to 400 fpm. Model X-2366 accommodates diameters from ¼ inch to 1½ inches. Its constant speed reduction motor, working through a V-pulley arrangement, offers 2-speed operation, either 180 or 300 fpm. **Magnaflux Corp.**, 7300 W. Lawrence Ave., Chicago, Ill.

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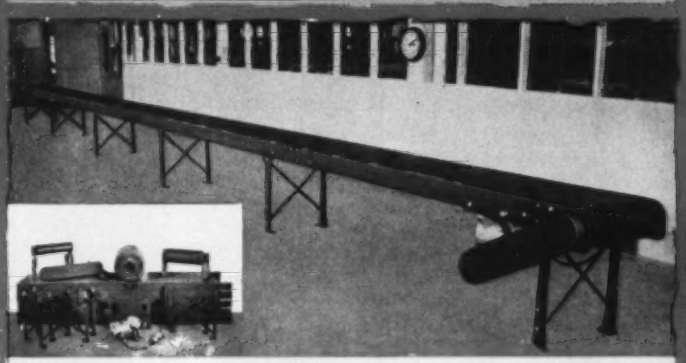
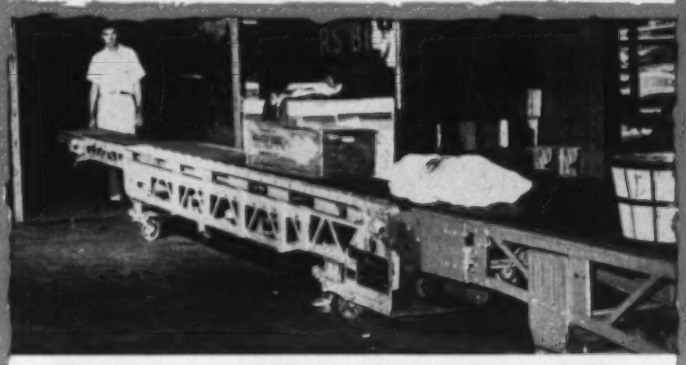
CSI Farquhar MEMBER



A fast, easy package handling conveyor set up in a few hours! No expensive installations with these CSI-Farquhar standard components. Available either for horizontal or floor-to-floor usage.



The versatile CSI-Farquhar EXPAND-O-VEYOR does a systematized loading job on boxes, crates, bags and other packages. Its built-in stretch gives you the *right* length for every loading situation.

SEND FOR COMPLETE DETAILS

Ask for literature on CSI-Farquhar's complete line of package handling conveyors. Complete with all essential information on specifications, sizes, applications and power requirements. Get your copy today.

CONVEYOR SYSTEMS, INC.
A-B FARQUHAR DIVISION
6453 Main Street
Morton Grove, Illinois
(Chicago Suburb)
Phone: JUniper 8-0200

YOUR OWN CUSTOM CONVEYOR SYSTEM with STANDARD COMPONENTS

- Installed in a few hours
- Constant or variable speeds
- Wide selection of lengths
- High capacity, incline or horizontal
- For all kinds of package handling

Here are low cost conveyor units you can use in package handling and loading. Build high capacity conveyor systems with *pre-engineered* CSI-Farquhar units. High efficiency *without high costs!*

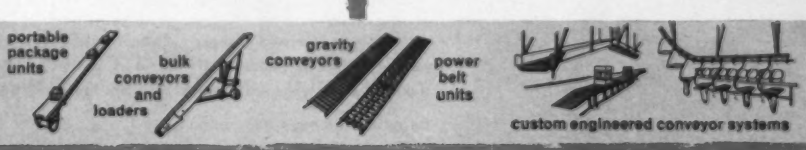
Set up a complete flow pattern from assembly line to shipping dock and on into the truck. Select units from the complete line—gravity, power belt, and portable—to make a systematized line *set up the way you want it.*

CONSULT YOUR YELLOW PAGES FOR THE NAME OF YOUR CSI-Farquhar DEALER or WRITE, WIRE or PHONE DIRECT!

CUSTOM CONVEYOR ENGINEERING

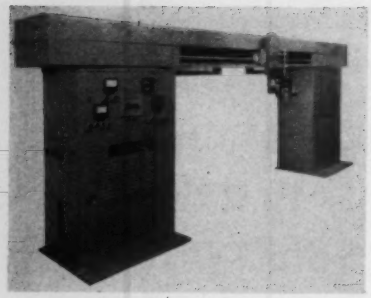
New Brochure No. 70 describes the complete service offered by CSI-Farquhar on engineered installations. It describes and illustrates many complex and specialized conveyor installations designed and built by CSI-Farquhar. Wide experience with all kinds of conveyors—trolley, in-the-floor types, spindle, mesh belt, barrel handling and many others. Our engineers can help you solve your conveyor problem efficiently and economically. Write for new Brochure No. 70 today!

CSI Farquhar MEMBER



THE COMPLETE LINE OF CUSTOM AND PRE-ENGINEERED CONVEYING SYSTEMS

Circle 691 on Page 35



ELECTRONICALLY CONTROLLED HYDRAULIC TRAVERSES

Series HJT hydraulic traverses provide uniform velocity reciprocating linear motion for a wide variety of industries. They feature pushbutton electronic controls. The units are used in a variety of industries in applications where carefully controlled reciprocating linear motion is required. For example, they can be used to carry urethane foam mixing heads, scanning instruments, x-ray equipment, cutting torches, welding heads, materials handling equipment, loading equipment, etc. A series of models of the traverse are available with maximum length of stroke ranging from 48 to 144 inches depending on the model. The traverse carriage accommodates loads up to 400 lb. Speed of stroke is adjustable from 0 to 240 ft per minute. **Jennings Machine Corp.**, 3452 Ludlow St., Philadelphia 4, Pa.

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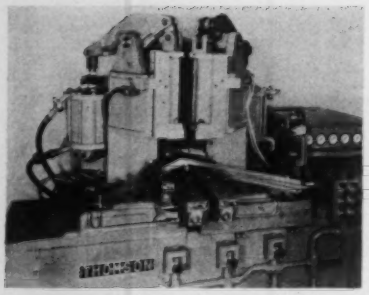

FLASH WELDER FEATURES HIGH CAPACITY BIDIRECTIONAL CLAMPING SYSTEM

Designed for joining mitered corners of extruded aluminum members, Model F-3 flash welding machine features a high capacity bidirectional clamping system, welding dies that nest in the extrusion, and adjustable components that allow up to one degree of angular variation to compensate for parts shrinkage. Design of the welder's pneumatic system and circuitry permits different clamping sequences. Both sets of clamps can be sequenced at once or each set can be operated independently. The welding cycle is controlled by a mechanism that produces 13,000 psi upset force at 80 psi air pressure through the movable right-hand platen. **Thomson Electric Welder Co.**, 161 Pleasant St., Lynn, Mass.

Circle 423 on Page 35

DATA PUNCH SIMULTANEOUSLY EMBOSSES AND CODE-PUNCHES PLASTIC PLATES

Machine, designated Electronic Databosser, will emboss and code-punch up to 3600 plastic or metal plates an hour directly from punched tab cards, punched tapes, or magnetic tape. It will punch either binary or decimal codes. The input can be Hollerith code or any binary code configuration, and can activate the machine to emboss alphanumeric information at the same time it code-punches the metal or plastic plates. Plates created by the machine are used for credit card plans, medical care programs, production controls of various kinds, and other areas where source data needs to be imprinted or recorded into data collection systems. **Dashew Business Machines Inc.**, 3655 Lenawee Ave., Los Angeles 16, Calif.

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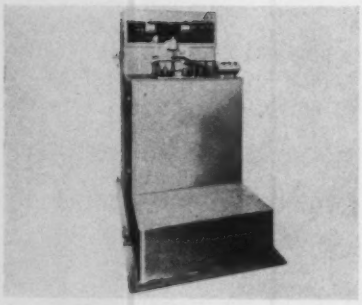

VALVE SPRING TESTING EQUIPMENT

Unit, designated Model 016, checks the compressibility of automotive transmission regulator valve springs at speeds of up to 750 per hour, sorting the parts into reject and three acceptable categories within a tolerance of 2 pounds over-all. Acceptable parts are also automatically color coded according to the compressibility range in which they fall. Features of the valve spring tester include very high reliability, accuracy, and 100 per cent repeatability. Standard gage heads and electronic modules are used throughout. **Industrial & Automation Div., Radio Corp. of America**, 12605 Arnold Ave., Detroit 39, Mich.

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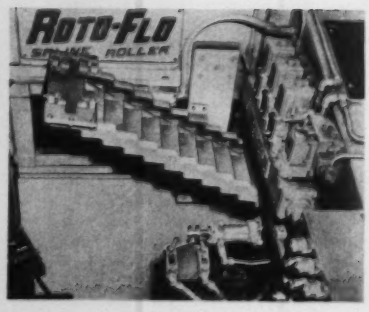


AUTOMATIC LOADER FOR SLENDER PARTS

Device loads, locates, and unloads long slender parts in production machines. It has been designed to prevent jamming or damage of parts. The Roto-Flo loader features a barrel-shaped escapement with axial slots that takes the shafts out of a stepped orienting chute. In the illustrated application unthreaded shafts are delivered to the loader in baskets on a roller conveyor, left. An operator places them in a slot at the top of the stepped chute. Configuration of the chute prevents jamming or excessive speed. Production rate is 470 shafts per hour. **Gear-O-Mation Div., Michigan Tool Co.**, 7173 E. McNichols Rd., Detroit 12, Mich.

Circle 426 on Page 35

A NEW ADDITION TO THE SONAC *LINE*

POSITIVE ULTRASONIC LEVEL CONTROL

The components of Sonac (sensor actual Size)

Now, two new ultrasonic sensors, especially for level control have been added to the Delavan line of SONAC sensing and switching devices.

The single sensor system is recommended for liquid level control and the double sensor system for dry level control.

Control is maintained by installing the SONAC sensor through the wall of the vat, bin or hopper. When the oscillation on the face of the sensor is dampened or impeded by the material being sensed, the signal to the control unit changes, activating a relay.

FIG. 1—LIQUID LEVEL (One Sensor)

FIG. 2—DRY LEVEL (Two Sensors)

For level control, SONAC is accurate to .005" and has a response time of 25 milliseconds. Performance of the sensor does not deteriorate with age.

The level control uses to which SONAC can be applied are virtually unlimited. It is not affected by the viscosity*, specific gravity, conductivity, or capacitance of the material being sensed. Temperature or pressure changes of the material do not alter its performance. False signals are eliminated because SONAC may be adjusted so as not to sense steam, foam, or vapors.

*Viscosity may affect response time.

Canadian Representative:

KNOWLES & FOSTER (North America) Ltd.

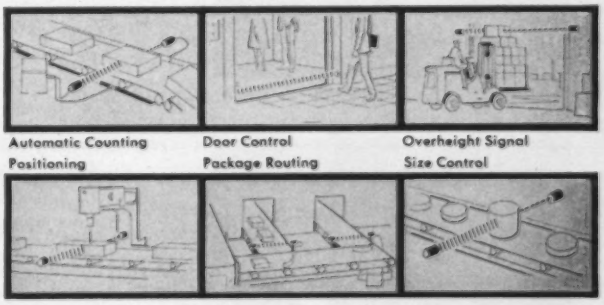
708 Terminal Bldg., Toronto 1, Ontario, Canada

Circle 692 on Page 35

SONAC is extremely rugged. Sensors are type 304 stainless steel. The electronic components in the sensors are hermetically sealed and will withstand pressures to 2000 psi and temperatures from −425° F. to +450° F. They are immune to shock, vibration or mechanical damage.

The control is a compact unit 5" x 5" x 5" and features transistor circuitry. Power consumption is one watt and the unit will operate in temperature ranges from 40° F. to 135° F.

Here's how SONAC can be used for sensing and switching applications other than level control.



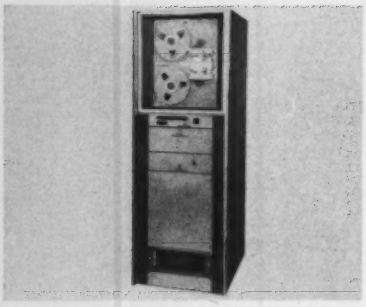
Automatic Counting Positioning | Door Control Package Routing | Overheight Signal Size Control

There are dozens of applications for SONAC *single and double sensor units. Let it go to work for you now, write:*

DELAVAN Manufacturing Company

WEST DES MOINES • IOWA

A



HIGH PRECISION TAPE HANDLER SYSTEM

High density system reads and writes tapes at packing densities of 1200 bits per inch with extreme reliability. Transient error rates are fewer than 1 bit in 10^8; permanent error rates are less than 1 bit in 10^{10}. More than 20,000 passes of the same tape can be made without losing information or increasing the transient dropout rate. This PH-1200 system incorporates a digital magnetic tape transport, a dual read/write head assembly, read/write amplifiers, deskewing buffer, manual control unit, and power supplies. Standard record input signals are one microsecond negative-going pulses of 7.5 v minimum amplitude. Playback output signals are dc levels; 0 v for logical O and −7.5 v for logical *l*. **Potter Instrument Co. Inc.**, Sunnyside Blvd., Plainview, N. Y.

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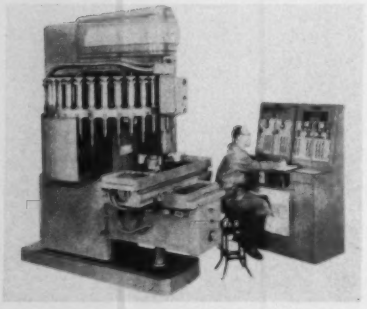

NUMERICALLY CONTROLLED DRILL HAS 32-SPINDLE TURRET

With a single complement of tools in its 32-spindle turret, this numerically controlled turret drill can perform an estimated 90 per cent of all the drilling-tapping jobs in an average shop. At one time the 32 spindles on the machine can store all the drilling, reaming, tapping, milling, and counterboring tools needed for hundreds of different jobs. They are ready for action at the command of a punched tape. The drill has ample power (3 hp) to handle a 1½-inch drill in cast iron and still is capable of tapping a No. 2-56 thread. Spindles have 8 feed rates from 0.001 to 0.030 inch per revolution and 16 speeds ranging from 65 to 2500 rpm. Table has 18 by 24 inches of travel. It moves in rapid traverse at 200 imp. **Fosdick Machine Tool Co.**, 1638 Blue Rock St., Cincinnati, Ohio.

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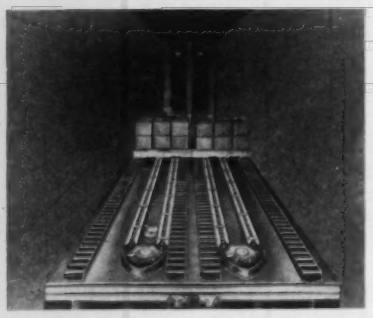

POWER PUSHER CONVEYOR FOR UNLOADING TRAILER TRUCKS

Conveyor has been developed especially for unloading trailer trucks. The pusher (actually a bar across back of truck, not seen in photograph) is activated by a motor drive. This drive pushes the entire palletized load onto a dock at a predetermined rate. A conveyor on the dock, the same width and length as the conveyor on the floor of the truck, completes the unloading process. The entire unloading sequence can now be performed in a fraction of the time it formerly took to unload by other methods. **Alvey-Ferguson Co.**, Oakley Station, Cincinnati 9, Ohio.

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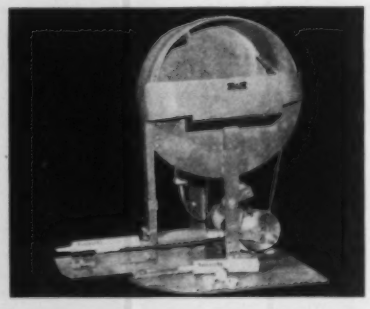

CAPPING MACHINE CAPABLE OF PRODUCING 30-60 PARTS PER MINUTE

Automatic application of cupped inserts, caps, thread protectors, discs, and other short cylindrical parts is practical with this machine attachment. Developed for feeding and applying metal and plastic and caps for caulking compound packaging, it is a standard device for a wide variety of industrial applications. Thirty to 60 parts per minute, in sizes up to 6 inches OD and larger can be obtained from fully automatic units in conjunction with other operations or from manually loaded individual cappers. This machine is available in the motor driven, clutch-actuated model illustrated or in air-operated units. **Von Machine Co.**, 531 Linda, Rocky River 16, Ohio.

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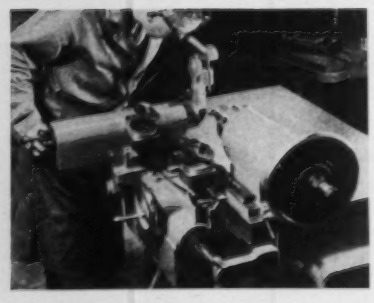

PRECISION TOOL PRESETTING MACHINE

Machine is designed to preset precision cutting tools to accurate tooling requirements for numerically-controlled machine tools. It enables cutting tools to be preset for both diameters and depths to precise tolerances and handles boring bars, milling cutters, drills, and other accessory tooling. The machine consists of a precision presetting spindle mounted on a base, and arranged with transverse and longitudinal slide adjustments. It offers a tool setting capacity of 8 inches diameter maximum, and 18 inches depth maximum. Vernac direct reading optical measuring instruments on the slide elements can be read to 0.0001 inch with interpolation. An illuminated microscope with special cross hair reticule, mounted on the slides, optically sights the tool point. **Microbore Div., DeVlieg Machine**, Royal Oak, Mich.

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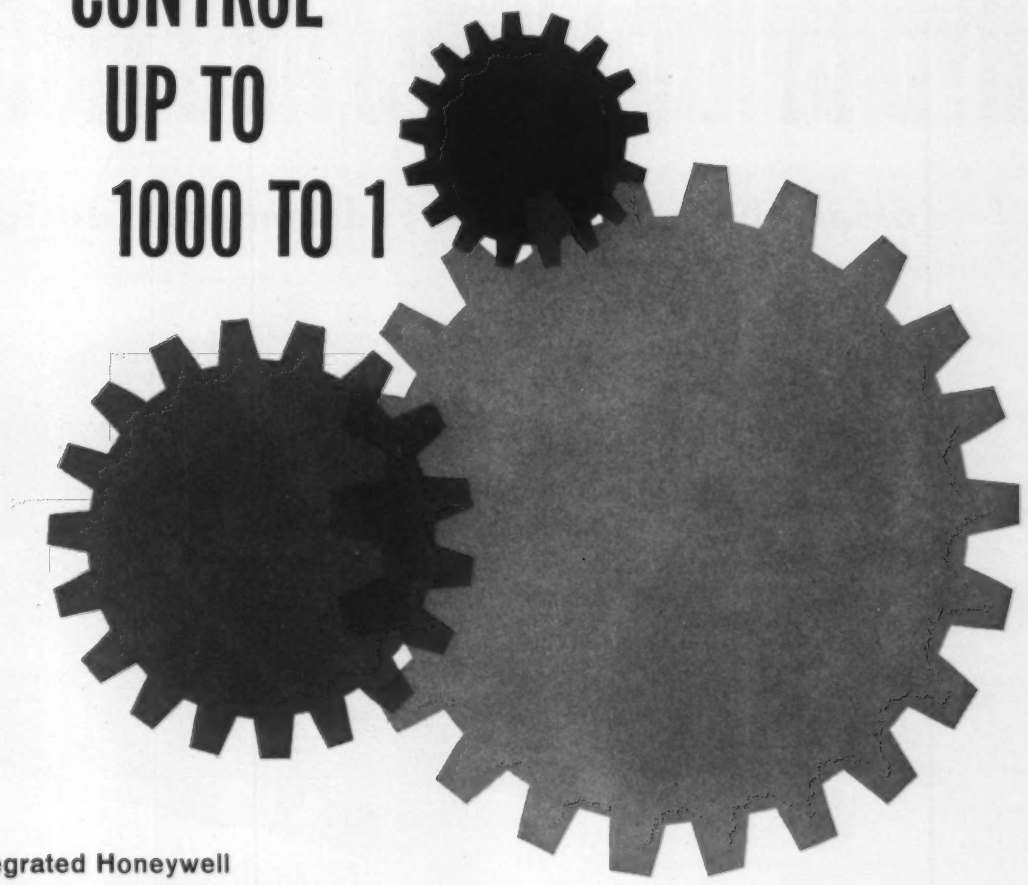
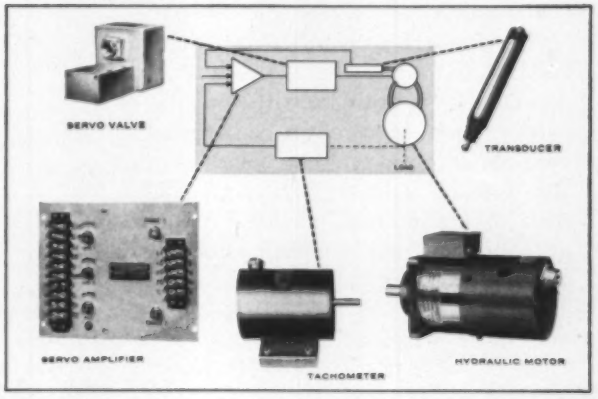
SPEED CONTROL UP TO 1000 TO 1



Integrated Honeywell speed servo control systems assure smooth, steady operation!



A matched Honeywell Speed Control system can assure you of precision control at any speed. Based on the "building block" concept, a Honeywell system is easily adaptable to a wide range of industrial uses. The basic components of a Honeywell Speed Control system are proportional servo amplifiers, transducers and electro-hydraulic servo valves. Each Honeywell component has been compactly designed and ruggedly built to insure long-life and continuous reliability.

In addition to their sturdy construction Honeywell Speed Control systems offer negligible droop under load fluctuations and smooth, steady low-speed operation.

For details on any or all of Honeywell's Speed Control systems, write Honeywell, Dept. AO-8-138, Minneapolis 8, Minnesota.

Honeywell

First in Control

SINCE 1885

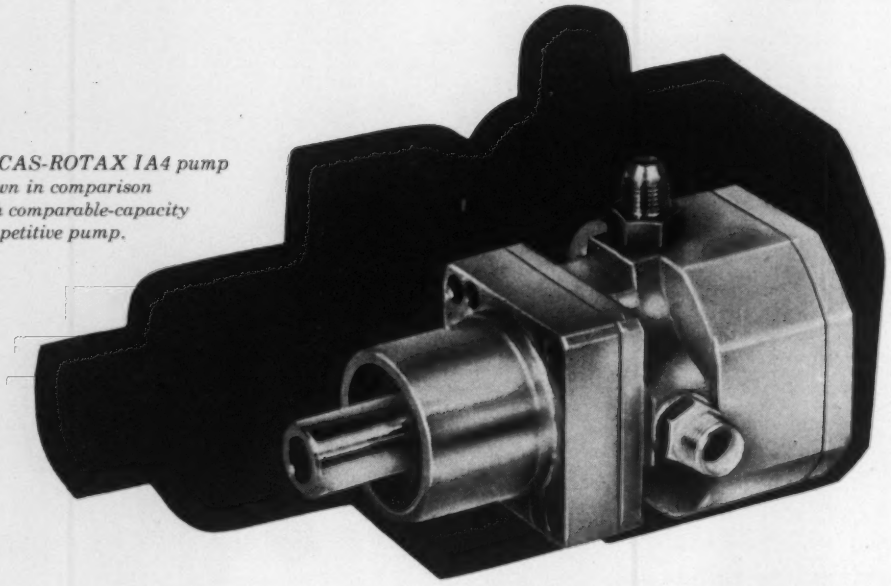
HONEYWELL INTERNATIONAL
Sales and Service offices in all principal cities of the world. Manufacturing in the United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Circle 693 on Page 35

new LUCAS-ROTAX *industrial*

HYDRAULIC PUMPS AND MOTORS

offer the most advanced compact design



LUCAS-ROTAX IA4 pump shown in comparison with comparable-capacity competitive pump.

If you are interested in industrial hydraulic pumps or motors in the 1.5 to 108 g.p.m. range at pressures to 5000 p.s.i., you'll find more good design features in Lucas-Rotax pumps and motors than in any other quality line.

Lucas-Rotax industrial hydraulic pumps and motors are smaller and lighter than conventional units with low noise level in spite of high operating speeds. They offer fast response rate in pressure compensation and the low and medium capacity units can be operated from 2-pole motors to reduce the cost of the prime mover.

Pumps are available as variable volume, variable volume pressure compensated, overcentre cam (reversible) or fixed volume. Motors can be supplied in variable or fixed volume. Both pumps and motors deliver high performance with minimum maintenance. Available in quantity from domestic stock—call or write for technical data.

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6004

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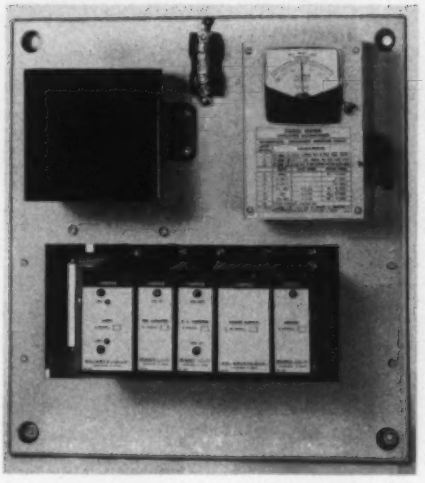
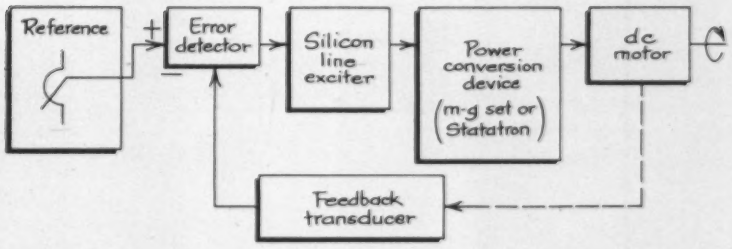
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 35.





Silicon Line Exciter, left, provides control and motor field excitation in variable speed drive systems developed by Reliance Electric & Engineering Co. Static plug-in modules in bottom row can be combined in different arrangements to meet most industrial control requirements. Block diagram, above, shows basic elements of variable speed drive system with feedback control. Statatron power converter also uses static components for improved unit reliability, small size, and long life.

Variable Speed Drive Systems

TWO NEW developments in its line of V*S drive systems have been announced by **Reliance Electric & Engineering Co.**, 24701 Euclid Ave., Cleveland 17, Ohio. The systems provide wide range, infinitely variable drive speeds from standard ac power sources.

A basic V*S drive system employs a power conversion device that converts ac to dc, an exciter unit, and a dc motor or motors. For remote control, an operator's station unit contains motor control pushbuttons and a selector dial to provide command inputs to the exciter unit.

Where closed loop control is required, the input to the exciter unit is a signal reflecting the difference between a reference signal and a feedback signal. Feedback signals may be based on speed, tension, load, pressure, angular position, or other characteristics for which transducers are available. Typical transducers include tachometers, current measuring devices, strain gage devices, differential transformers, and dancer roll-potentiometer arrangements.

The block diagram illustrates the major elements in a closed loop V*S drive system using feedback. In such a system, the power conversion device may be a motor-generator set or a Statatron power unit. M-g sets are used where regenerative motor braking action is required in power ranges from 1 to over 1000 horsepower. Statatron power units employ silicon diodes and saturable core reactors to provide a completely static assembly. Available in power ranges from 1 to 300 horsepower, these units can include dynamic braking.

Silicon Line Exciters have also been developed (see photo) that employ static semiconductor elements. An important feature of these units is use of a silicon controlled rectifier bridge that provides a full-wave, rectified ac output of controlled pulse duration to excite the generator field in a m-g set, a Statatron power unit, or the field of a dc motor.

Up to seven standard, encapsulated modules may be plugged into the Silicon Line Exciter to provide over 50 workable control combinations to meet most needs. Typical modules are: A power supply, preamplifier, dc amplifier, driver, and a limit unit that provides control override action. Also available with the exciter is an integrally wired test device that can be used to check the operation of each module and the entire control combination. A multiposition switch is used to select particular types of tests, and results are indicated on a meter.

Circle 432 on Page 35

NEW Stromberg-Carlson® lightweight telephone handsets

. . . for a wide range of applications such as dictating systems, mobile radio, carrier and microwave.

These new lightweight Stromberg-Carlson handsets, No. 33 and No. 35, incorporate push-to-talk switches, broadening the range of their applications. Both feature high-gain, high-efficiency transmitter and receiver.

The No. 33 model is furnished with a bar-type switch, located on the underside of the handle.

The No. 35 handset is furnished with a button switch on the side of the handle near the receiver end. Also available with both button and bar switches.

For technical details and ordering information, contact any of these sales offices: Atlanta—750 Ponce de Leon Place, N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Ave.; San Francisco—1805 Rollins Rd.

GENERAL DYNAMICS /ELECTRONICS

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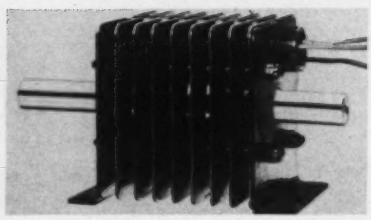

Linear Actuator

Electromechanical linear actuator utilizes induction principles to deliver a uniform long stroke. It is designed to meet a wide range of requirements. Six Polynoid linear actuator models featuring different stroke lengths and output forces are available from stock for testing, evaluation, and prototype use. These models operate on standard ac voltage and come furnished for foot mounting. This linear actuator contains only one moving part, the rod, and can be used to hold under load at any position or provide reciprocating motion. Stroke is up to 6 inches with standard units. Uniform output force can be produced throughout the actuator's stroke in either direction. Output force is directly proportional to input power. **Skinner Precision Industries Inc.**, New Britain, Conn.

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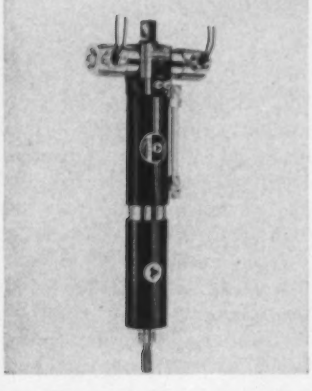

Tandem Cylinders

Cylinders feature two pistons mounted on one common rod and are intended to combine the advantages of an air operated valve-in-head cylinder with the advantages of hydraulic control. Hydraulic fluid can be used either in the front cylinder or in the middle section of the unit without the need for a make-up chamber. Accurate speed control is obtained by piping flow control valves in series with the ports of the front cylinder filled with hydraulic fluid. The cylinders are available in bore sizes of 1½, 2, 2½, 3, and 4 inches in lengths up to 80 inches. A choice of mounts is offered as well as a choice of 48 different models of valve-in-head cylinders for the power section. **Allenair Corp.**, 255 E. 2nd St., Mineola, N. Y.

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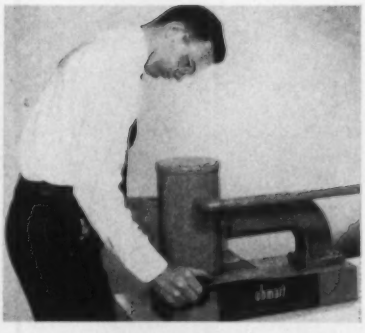


Nuclear Thickness Gage

Nuclear thickness gage, using beta radiation, has been developed for applications in industrial research laboratories and pilot plant operations. Measuring only 22 inches in length, it will accurately indicate or record the thicknesses of sheet materials up to 12 inches wide. This gage is useful in the laboratory determination of thickness or density of plastic films, paper, coated materials, rubber, glass floor coverings, and metal foils. Another possible application is continuous screening of sheet steel or aluminum being fed into production dies to prevent oversize sheets from damaging the dies. The unit can also be employed as a secondary check on production line thickness gages. Available in three different models—LBKR, LBSR, and LBMS, the gage uses two different radiation sources. Krypton 85 is used for very thin materials, and full scale spans as narrow as 0.004 inch of paper and 0.002 inch of aluminum are obtainable. With Strontium 90, the minimum thickness ranges are 0.02 inch for paper, 0.008 inch for aluminum and 0.0025 inch for steel. Gage repeatability in all cases is ±2 per cent of scale or better. If greater thicknesses are to be measured, Strontium 90 is

CHROMALOX ELECTRIC HEATERS

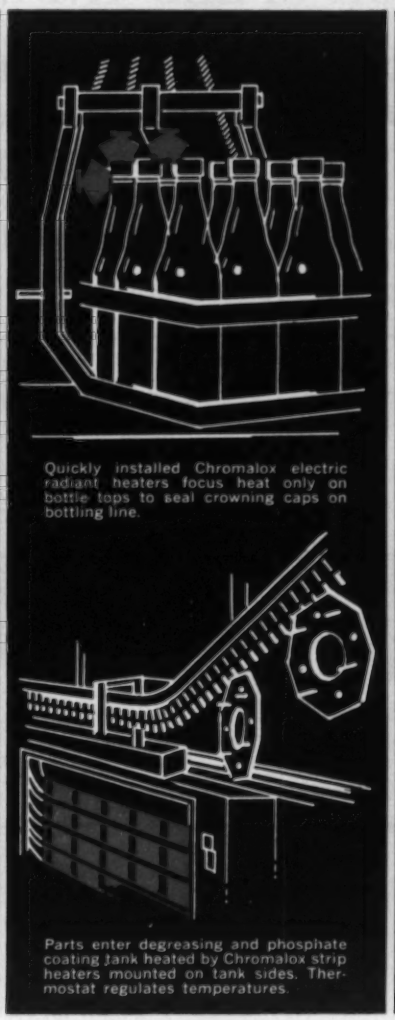
provide precise, uniform heat centers on automated operations, regardless of product size or shape

Precise control, from 0 to 100% of output, can be made an integral part of a Chromalox far-infrared heating installation. Temperatures are "dialed."

Compact far-infrared units interlock into self-forming ovens. Single or double heat sources in lengths from 24" to 185", many wattages.

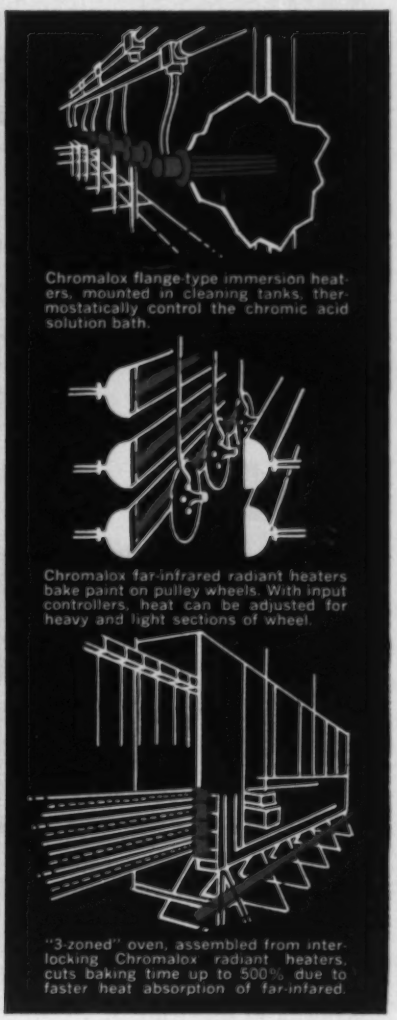
Straight lengths, formed or "finned" Chromalox strip heaters in 50 to 6,000 W; ¾", 1", 1½" widths; 5" to 96" lengths.

Chromalox immersion heaters — for heating water, oil and other liquids. 3" to 14" pipe flanges— with or without built-in thermostats.



Quickly installed Chromalox electric radiant heaters focus heat only on bottle tops to seal crowning caps on bottling line.

Parts enter degreasing and phosphate coating tank heated by Chromalox strip heaters mounted on tank sides. Thermostat regulates temperatures.



Chromalox flange-type immersion heaters, mounted in cleaning tanks, thermostatically control the chromic acid solution bath.

Chromalox far-infrared radiant heaters bake paint on pulley wheels. With input controllers, heat can be adjusted for heavy and light sections of wheel.

"3-zoned" oven, assembled from interlocking Chromalox radiant heaters, cuts baking time up to 500% due to faster heat absorption of far-infared.

Chromalox electric heating equipment can help you automate your production lines to cut costs, improve production and/or reduce rejects . . as well as solve many of the critical heating problems encountered in line production. They are frequently used to boost existing heat-source temperatures. Among the Chromalox advantages are easy, low cost installation; dependable and economical operation; minimum attention and maintenance. Whatever you need for heat—whether for production-line or other processing applications—Chromalox electric heaters can provide exactly the heat source you require. Engineering assistance is available without obligation. Write, wire or phone.

FOR YOUR INFORMATION

Write for Catalog 60. It details uses for electric heat and describes thousands of types, sizes and ratings of Chromalox units.

EDWIN L. WIEGAND COMPANY
7746 THOMAS BLVD., PITTSBURGH 8, PA.
WI-24

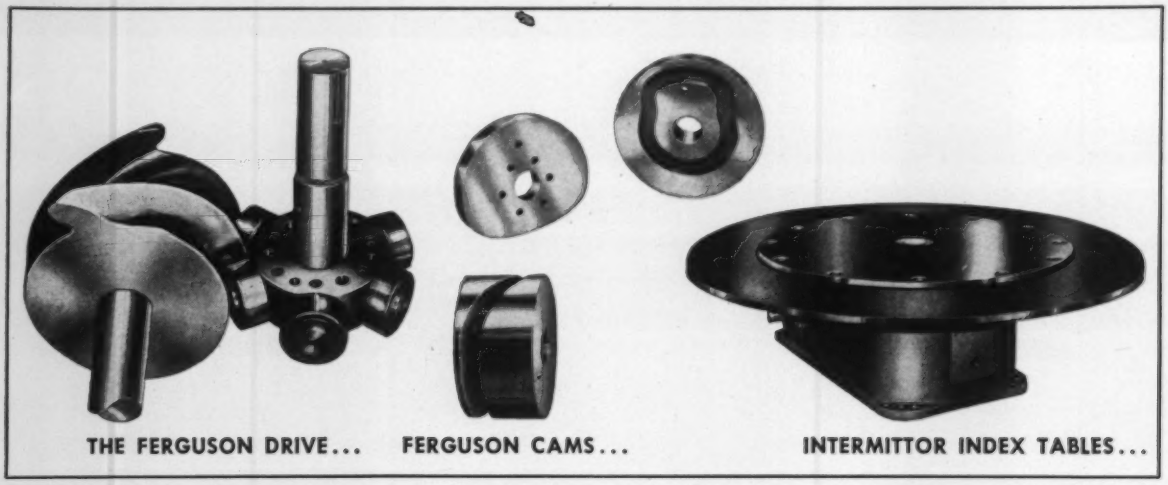
CHROMALOX
ELECTRIC HEAT
PROCESS COMFORT

Circle 696 on Page 35

See why today's Designers DO MORE with FERGUSON HIGH SPEED INDEXING equipment

SEND FOR FREE ENGINEERING DATA ON THESE IMPORTANT AIDS TO MODERN PRODUCTION...

Load ratings, Dimensions, Application and Installation data in complete catalog form—information that belongs in every engineer's library!



THE FERGUSON DRIVE...

Provides up to 2,000 precision indexes a minute for high-speed production—and is rated for high-speed operation for 8,000 to 20,000 hours with no maintenance. No auxiliary locating or locking required. Nearly 100 standard units catalogued for your selection. **CATALOG 161.**

FERGUSON CAMS...

Dynamically designed, precision made face, plate and barrel cams have job-suited accelerations. Standard and semi-standard units reduce tooling charges and manufacturing costs. Ferguson provides unity tables which allow complete flexibility in solving special cam problems.

CATALOG 903.

INTERMITTOR INDEX TABLES...

Provide up to 30,000 assemblies an hour. Available in 12″ to 120″ dials with 4 to 36 stops, and providing 90° to 270° indexing in all standard units. Tables, power assemblies, control panels, and stands available... also standard dial feeds for presses and rotary machines with integral press stations. **CATALOG 161.**

Write for information on these Ferguson products and services:

indexing mechanisms • index tables • press feeds
power transmitters • in-line machines • engineering
services • tool and machine design • pre-production
planning • machinery development and debugging

FERGUSON
MACHINE COMPANY

A Division of Universal Match Corporation

7818 Maplewood Court • St. Louis 17, Missouri

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provided in a source to produce low energy radiation. **Ohmart Corp.**, 2236 Bogen St., Cincinnati 22, Ohio.

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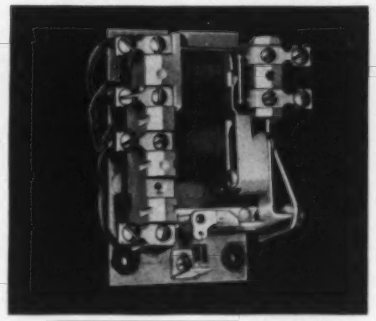
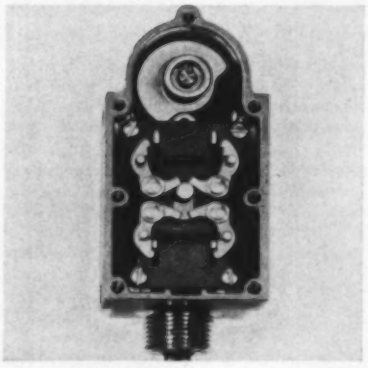


Remote Pump Control

Relay is designed to provide a method of remote control with maximum dependability and safety of a low voltage, low-energy circuit. It can be installed at the pump location with the motor control box. A single, Size 18 or larger wire between the pressure switch and the relay insures positive pump operation, if a ground return is used. If desired, a loop circuit may be wired between the pressure switch and Type L relay. This can be installed underground or overhead. **B/W Controller Corp.**, 2200 E. Maple Rd., Birmingham, Mich.

Circle 436 on Page 35



Limit Switch

Virtual elimination of limit switch failure is accomplished by the application of an epoxy resin to isolate the switch from the entry of moisture. This super-sealed switch is guaranteed for at least 10 million cycles or one year of opera-

TRANSACTER

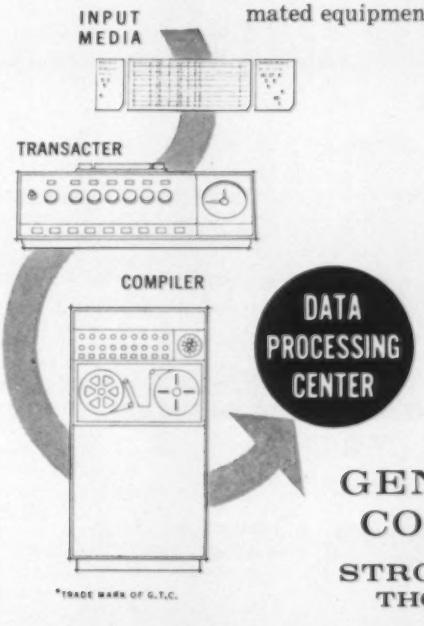
AT THE GARRETT CORPORATION
AiResearch Manufacturing Division

AiResearch, Phoenix announces an intensive modification program in manufacturing controls aimed at reducing production time. The heart of this program is continuous status reporting on every machine and part in production by the TRANSACTER* System.

Throughout the plant, the TRANSACTER System units provide an incredibly accurate, instantaneous link between widely scattered factory locations and central data Compilers which receive the messages, digest them and feed continuous punched tape to the data processing nerve center.

Not only is production status continuously reported—so too, is order location, inventory control, tool crib and stores control—all contributing to accurate labor costing—together with continuous reports of receipt and shipment. These are a few of the many potential assignments for the TRANSACTER System.

At AiResearch, Phoenix management reports that have heretofore taken days, can now be produced in minutes by the completely automated equipment.



Write for informative brochure. If you prefer, a qualified representative will call.

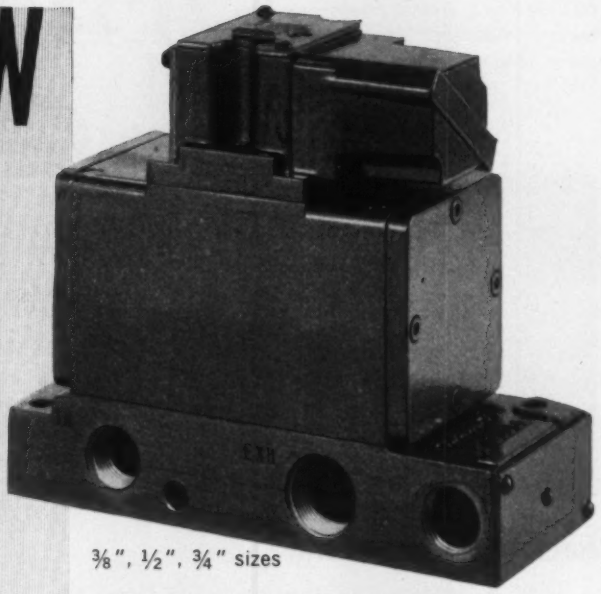
GENERAL TIME CORPORATION
STROMBERG DIVISION
THOMASTON 4, CONN.

*TRADE MARK OF G.T.C.

MAKERS OF THE WORLD'S FINEST TIME EQUIPMENT

Circle 698 on Page 35

NEW HANNIFIN "HUSTLER" VALVES GIVE YOU SPEED, SURENESS & GOOD SERVICE



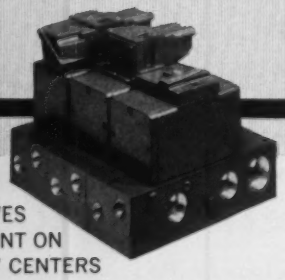
3/8", 1/2", 3/4" sizes

ALL the features you want in 4-way, pilot-operated air control

HOW FAST? So fast it fills 12 cu. in. test chambers from 0 to 90 psi in 0.029 seconds. Larger, 100 cu. in. chambers fill in 0.075 seconds. Valve itself has been cycled on test over 3,000 times a minute. We know of no faster valve.

HOW SURE? Valve will operate on severely restricted air supplies and at pressures down to 15 psi, thanks to a reserve volume of pilot air, maintained at maximum line pressure in a self-restoring accumulator chamber (patent applied for). Low-wattage, nylon encapsulated, plug-in solenoids are guaranteed for life against burnout. New "Comb-O-Seals"—one-piece, pressure-energized—seal positively, cannot be improperly assembled. Any of today's varied air line lubricants can be used. Both pilot valve and main valves operate on poppet principle, cannot stick in dirty air.

HOW GOOD? Good for millions of leak-proof cycles! All-aluminum, die cast construction gives you light weight, assures clean, smooth air passages. Base mounting—all connections, air and electrical, are permanently made to the base. Quick plug-in feature—entire operating unit "plugs" into base; remove two screws and it lifts off easily and quickly. Locking manual over-ride is standard on all solenoid models. All models fully meet J.I.C. standards.



VALVES MOUNT ON 3 1/8" CENTERS

ADD-A-FOLD BASES (optional) permit joining a number of valves together, with one supply, one exhaust, one gallery for electrical connections.

You can have either maintained or momentary contact electrical actuation—or remote pressure actuation. Valve is available in 3/8", 1/2" and 3/4" pipe sizes. Write for new Bulletin 0611-B1.

PARKER HANNIFIN CORPORATION

HANNIFIN COMPANY

A DIVISION

541 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

2419-PH

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tion. It is also rendered tamper-proof by fastening switch covers to housings with drive screws. The material used to seal the switch has high dielectric strength and unusual chemical stability, including resistance to solvents. It also possesses excellent mechanical properties including high resistance to heat and shock, unusual tensile and compression strengths, and low shrinkage coefficient. **National Acme Co.**, 170 E. 131st St., Cleveland 8, Ohio.

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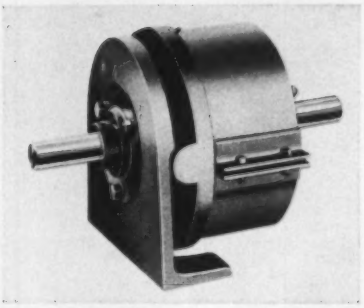

Disc Brake

Floor mounted through-shaft brake with its own ball bearing mounted shaft is intended primarily for applications where it is necessary to drive through the brake. It eliminates or minimizes alignment problems. The 55,200 series disc brake is ac operated. It is available in torque ratings of 1½, 3, 6, 9, 10, and 15 lb ft. **Stearns Electric Corp.**, 120 North Broadway, Milwaukee 2, Wis.

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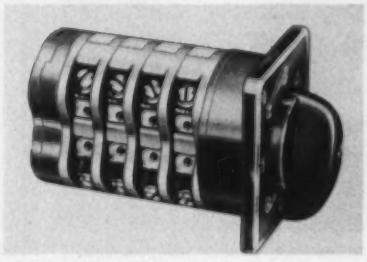
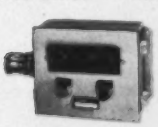


Rotary Switches

Switches, designated Models C-25 and C-40, are designed for power switching and motor control. C-25 is rated for 25 hp at 600 volts, 3 ph, and C-40 for 40 hp. The switches are constructed of modular stages

Dynapar is the electronic subsidiary of The Louis Allis Co. We make a full line of transistorized digital devices for high-speed counting, measuring, and control.

Information on any of these products can be obtained from your local Louis Allis District Office — which is listed in The Yellow Pages under "Electric Motors."


Draw Indicators

Process Controllers

Rotopulsers

DYNAPAR CORP., 463 E. STEWART ST., MILWAUKEE 1, WIS. *A subsidiary of The Louis Allis Co.*

Circle 700 on Page 35

We offer recommendations designed for the application

ALLISPEDE* DRIVE
A low-cost, accurate mechanical drive. Easily adjusts manually or by optional electric remote control. Simple maintenance. Speeds up to 10,000 RPM, speed ranges from 10:1, ½ to 30 HP. Configuration can be readily changed in the field to meet new requirements. Ask for Bulletin 3601.

SELECT-A-SPEDE* DRIVE
Converts incoming AC power to DC output at the motor to provide a highly responsive, precision drive. Drive motors are available in all types of enclosures. Transistorized control panels permit easy field modifications at any time to suit changing conditions. Available in ratings up to 400 HP. Ask for Bulletins 101 and 2001.

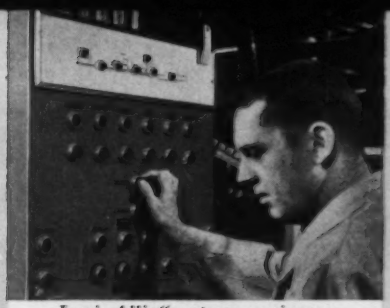
MAGNETIC DRIVE
For applications from 50 to 2500 hp. Liquid cooled magnetic clutch provides precision controlled adjustable speed. Wide speed range with minimum of drift. Available in one, two, three, or four-field construction . . . with or without magnetic brake. Ask for Bulletin 3650.

SYNCRO-RANGE DRIVE
A sophisticated "package system," Syncro-Range Drive from 2 to 200 hp combines an adjustable frequency power supply with compact squirrel cage induction or Syncro-Spede* synchronous motors. Controller offers one-point control of multi-motor process lines. Ask for Bulletins 110, 111, 112.

AJUSTO-SPEDE* DRIVE
Eddy current clutch and a-c motor combination provides stepless, accurate speed control. No brushes, slip rings, or commutators. Simple one-dial control. Sizes ¾ to 100 HP. Offered with wide variety of features including transistor control. Ask for Bulletins 2750 and 2800.

*TM of Eaton Mfg. Co.

NEW design news from Louis Allis



Louis Allis "systems engineering" can provide control for a single process line . . .

or entire plant coordination!

An outstanding line of LOUIS ALLIS adjustable-speed drives from ½ to 2500 hp.

Louis Allis offers you a complete line of adjustable-speed drives with various characteristics for every application where adjustable speed is required.

Experienced Louis Allis field engineers will help you select the best drive for your application. They are supported by regional and factory industry specialists who can recommend a drive system to meet *your* requirements.

The Louis Allis line of drives provides outstanding control features ranging from simple manual to precise electronic or transistorized control. Selection of control varies, of course, with the nature of the installation and the precision required. Where desirable, speed regulation as close as .1% is obtainable.

Controls can be provided which automatically respond to temperature, pressure, or flow. Other control features include threading, inching, jogging, logarithmic acceleration, torque-limit acceleration, tachometer feedback . . . and many other control provisions that can exactly tailor a Louis Allis drive to *your* operation.

For process plants or applications involving inter-related motors and multiple drives, Louis Allis engineers can provide complete "systems engineering" furnishing all electrical rotating components and control.

For expert assistance call your local Louis Allis District Office listed in the Yellow Pages under "Electric Motors" . . . or write direct to The Louis Allis Company, 463 E. Stewart St., Milwaukee 1, Wisconsin. Ask for Bulletin 2900.

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

A88-230

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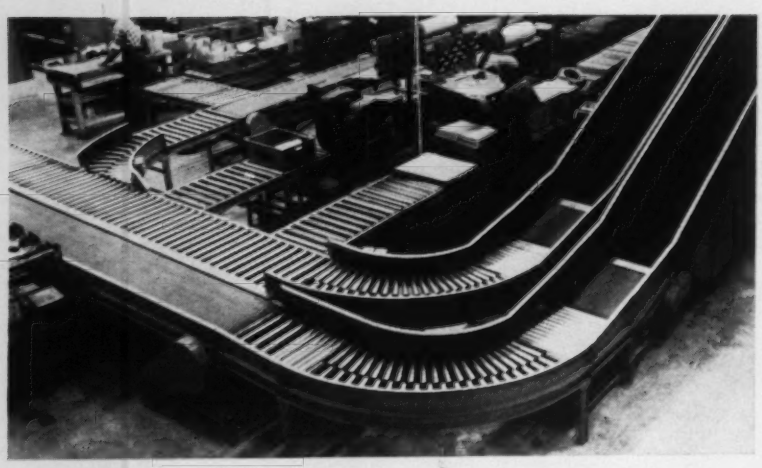

WHO, But A-F Could Have Engineered This Conveying System To Operate So Efficiently?

For the rapid movement of cases throughout this modern plant and warehouse, A-F Engineers combined A-F Roller Conveyors and A-F Belt Conveyors into this fully automated system.

Whatever your unit handling requirements—a simple gravity conveyor or a complex system, A-F would appreciate a call—or—

Write us, without obligation—today!

A-F

A-F *ENGINEERED* CONVEYING SYSTEMS

Also Pre-Engineered Conveyor Components
Wheel, Trolley, Roller, Belt

THE ALVEY-FERGUSON CO., 171 Disney St., Cincinnati 9, Ohio

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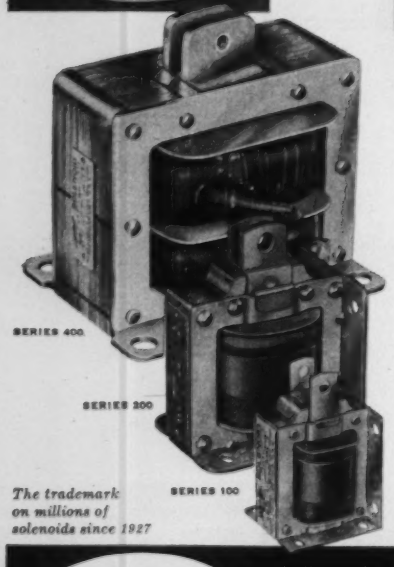
WesCo

has the AC solenoids you need... in the quantity you need!



The trademark on millions of solenoids since 1927

WESCO's famous Series 100, 200 and 400 AC solenoids—75 models in all—are immediately available in small or large quantities! One of these designs may fit your requirements. If not, WESCO engineers will design a special solenoid for your application. Inquire now.

WesCo designs and manufactures aircraft solenoids for military and commercial application. Write for complete catalog.

WesCo **WEST COAST ELECTRICAL MFG. CORP.**

233 W. 116TH PLACE • DIVISION 122 • LOS ANGELES 61, CALIFORNIA • PLymouth 5-1138

Circle 703 on Page 35

which permit modification of existing units without removal from mountings. Each stage contains two isolated double-break silver alloy contacts. The contacts are cam operated, providing an infinite variety of contact arrangements. Use of isolated contacts permits ordering only those stages needed for specific circuit requirements. Stages are easily added to existing units by a simple twist-to-lock bayonet principle. Up to 24 contacts are provided within 12 stages. Standard contact development can be arranged for 90, 60, 45, and 30-degree throw. **American Solenoid Co. Inc.**, U. S. Highway 22, Union, N. J.

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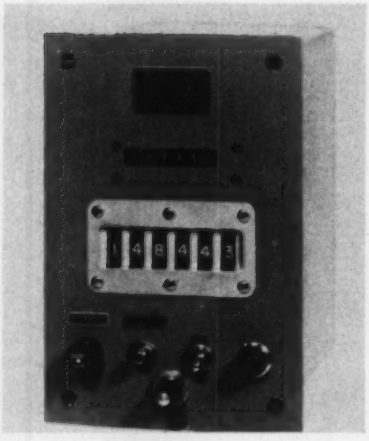
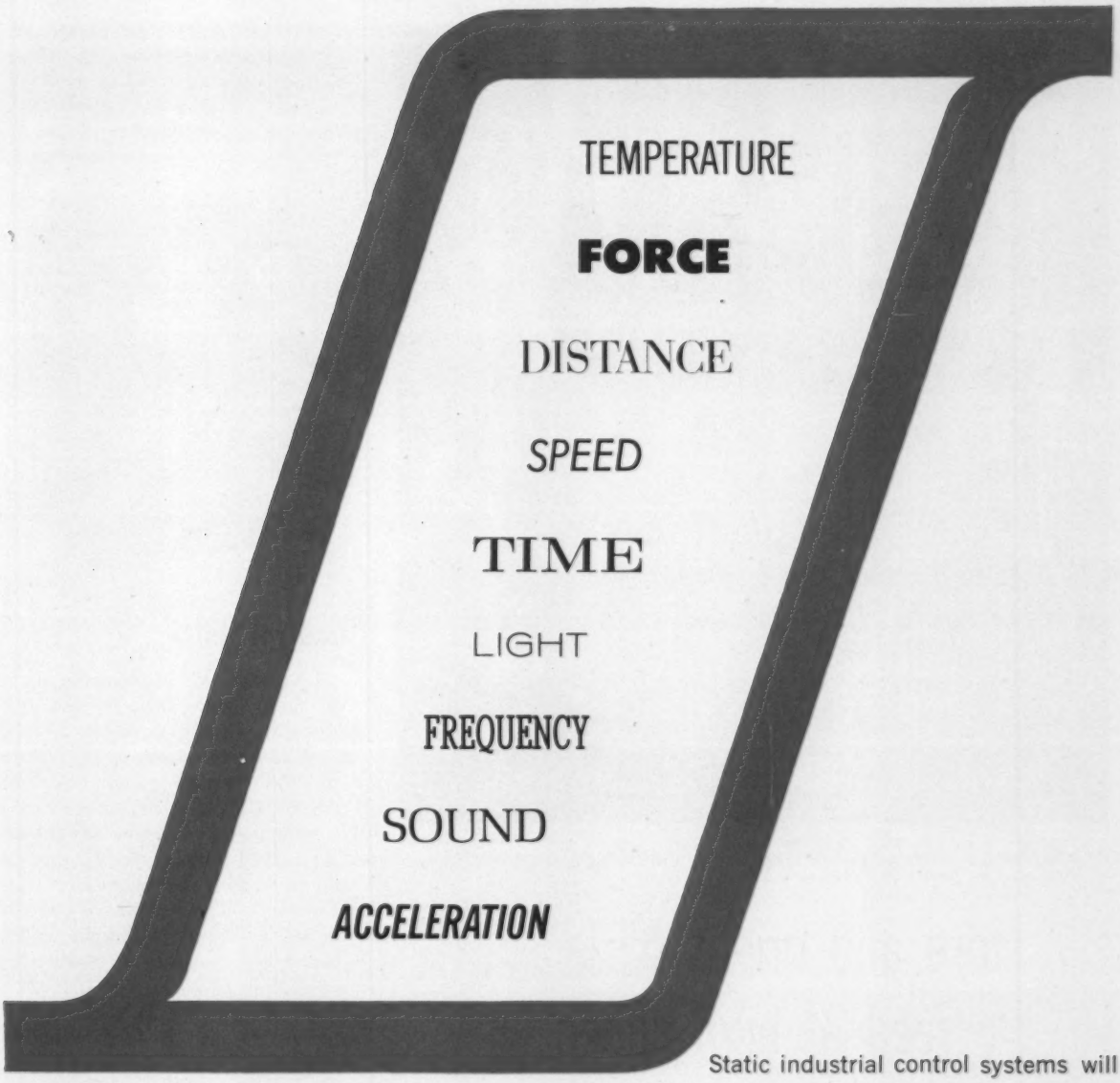


Predetermining Counters

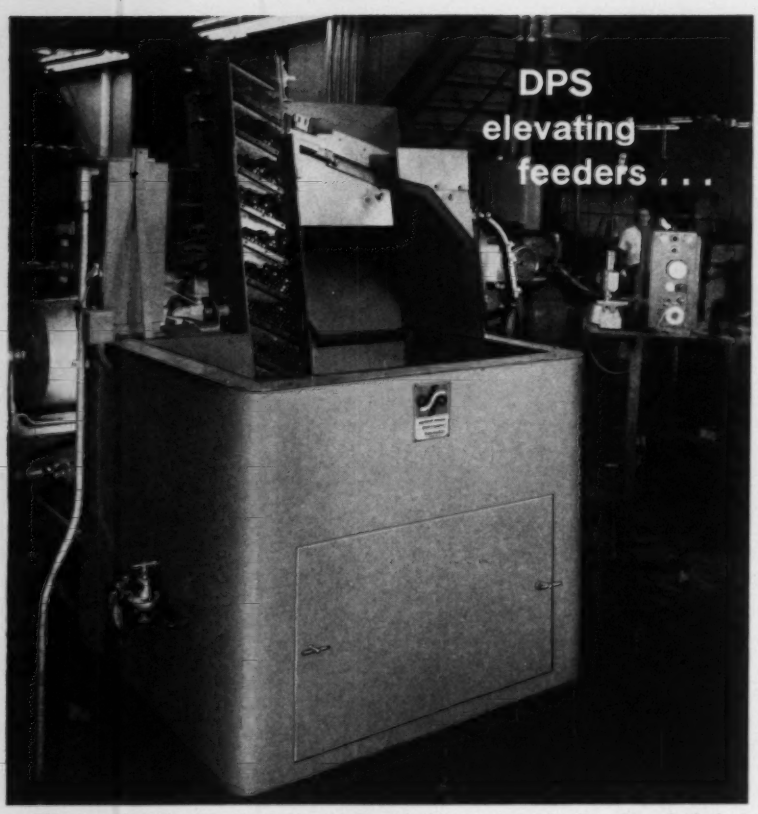
Line of electric predetermining counters, Series 1801, offers models for both original equipment manufacturers and existing equipment users for a variety of material handling applications, batch counting, length measurement, slitting, etc. The model available to original equipment manufacturers is designated P-1801 (illustrated) and features either four or six white on black decades. It provides an internal terminal strip for actuator and control lead connections, but is also available for plug-in wiring. Two models are manufactured for existing equipment users—Model A-1801 (with a single row of preset dials); and Model B-1801 (with two rows of preset dials). Both of these models are available with either four or six decades. Up to 1500 counts per minute can be registered on all three counters. They



Static industrial control systems will regulate virtually anything that is controllable — and under normal operation these *magnetic* systems will never break down, wear out or need servicing. Temperature (with precision to ±1/4°F at 2200°), position (with logic involving *and, or, not, memory* and *time delay),* speed, force, light, sound, acceleration, frequency, distance, field strength and pressure are but a few. ■ One manufacturer has replaced a vacuum tube-mechanical relay system on his high-speed assembly lines. Reason: it broke down every three weeks. The replacement magnetic static control system has now gone through 26,000,000 consecutive cycles without fault. ■ The symbol above, the magnetic hysteresis loop, , may encompass some of your control problems which are solvable at a lower overall cost. May we discuss this with you? Magnetics Inc., Department A-93, Butler, Pennsylvania.

INDUSTRIAL CONTROL EQUIPMENT

MAGNETICS inc.®



This 6-cu. ft. DPS elevating feeder handles 36 different sizes of rollers for spherical roller bearings. Rollers are elevated to feed track, where they are oriented, and sent along track to grinder in a continuous flow.

store and orient parts . . . feed at high speed

Today, many processing and assembly machines are not producing at rated capacity because of inadequate feeding arrangements. Hand feeding methods are often unable to match rated capacity of modern equipment . . . production suffers.

DPS elevating feeders are helping industry meet their feeding requirements. They orient and feed parts gently, and in a continuous flow to match production rates . . . handle parts of almost any material (metal, plastic, felt, rubber, etc.) and of practically any shape. Versatile in design, the elevating mechanism can be engineered to discharge parts to either side of feeder and at desired height. Feeders with 3, 6, 12 or 20 cubic foot storage hoppers are available.

Your DPS engineer is in a unique position to recommend the one best feeder from its line of rotary, vibratory and elevating types . . . the most complete in industry. Write or call today. Ask for elevating feeder folder 2812.

15,904

DETROIT POWER SCREWDRIVER CO.

A Subsidiary of Link-Belt Company

Selective Parts Feeders; Screw, Nut and Stud Driving Machines; Special Purpose Assembly Machines

2811 W. Fort Street Detroit 16, Michigan TAshmoo 5-3070

Circle 704 on Page 35

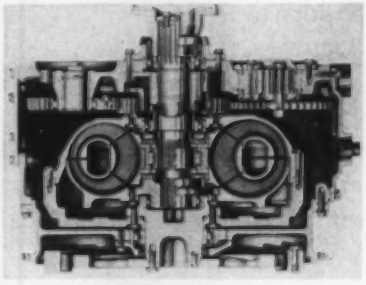
feature 150 millisecond electric reset, automatic reset in preparation for the following cycle, or pushbutton reset. **Electronic Controls Div., Veeder-Root Inc.**, Danvers, Mass.

Circle 440 on Page 35

Control Units

Transistorized dimensional control units are available for use with various types of gage tooling to provide automatic control of plunge cut and internal grinding operation. Four basic models cover single or double-limit control of ID or OD grinders. Each control unit is fail-safe, both pneumatically and electrically. The units have built-in testing facilities to permit rapid tracing and isolation of trouble independent of machine operation. Only one master is required for setting to size. **Federal Products Corp.**, 1144 Eddy St., Providence 1, R. I.

Circle 441 on Page 35



Torque Converters

Line of torque converters (cutaway view) has been specially designed to provide an infinite number of torque-speed ratios for off-highway vehicles, wheel and track-

Drilling? Boring? Seize Your Numerical Control Advantage

Buy no new jigs and fixtures. Convert storeroom space for useful work. Cut down heavy inventory investment. Tape control is taking over.

More than 500 hours and $5,300 went into making that obsolete drill jig in the foreground. It was used one year. You could make a tape to do the same work for $50, store it in an envelope, revise it for model changes in 20 minutes.

For low volume drilling, milling, turning, and a host of other metal-working operations, there just isn't any other way to beat the cost-cutting ability of numerical control.

Before making new drilling and boring fixtures, write for the bulletin "FPB" describing Fosdick's numerically controlled precision boring and jig grinding machines. Write for bulletin "FTD" describing the 32-spindle Fosmatic Turret Drill. It's time to "get a proposal from Fosdick!"

Write for bulletin "FPB"

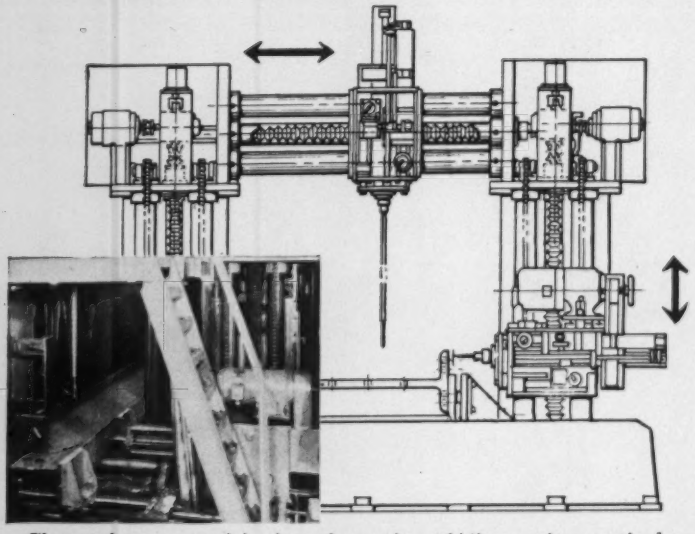
Write for bulletin "FTD"

FOSDICK

The Fosdick Machine Tool Company
Cincinnati 23, Ohio

Circle 705 on Page 35

Beaver Ball Screws help Mahon save 85% in drilling holes in bridge beams, columns

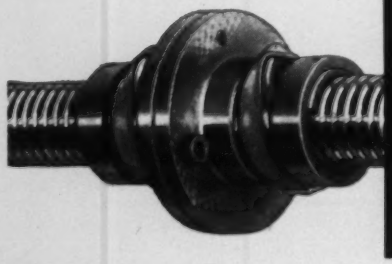


Close tolerance positioning of massive 1½" capacity vertical and horizontal drill heads is accomplished with Beaver ground-thread ball screws in this new, numerically controlled drilling machine, first in the structural steel industry.

Walter P. Hill, Inc., designed and built the machine for The R. C. Mahon Co., Structural Steel Division

In addition to the important drilling cost savings, it offers repeatability in hole pattern accuracy within ±.005" as compared with ±⅛" by conventional methods and eliminates costly hole reaming in final assembly.

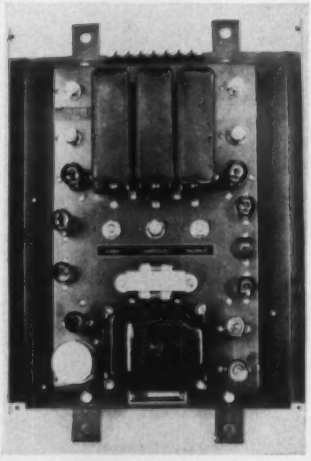
If you are considering data control, Beaver ball screws will give you the power efficiency, positioning control and compactness you need. Our engineers will be glad to work with you just as they did, in this case, with the Walter P. Hill designers.



Beaver Precision Products INC.
CLAWSON, MICH.

laying tractors, loader graders, rollers, stationary power units, and industrial drives. Handling loads from 100 to 700 hp, these converters have torque multiplication ratios from 2.3:1 to 3.5:1. Sizes range up to 18⅝ inches diameter. They are single stage, 3-element type with or without automatic over-running reaction members for fluid coupling operation. Especially suitable for power shift transmission applications, the converters are available in both rotating and stationary housing models. **Rockford Clutch Div., Borg-Warner Corp.**, Rockford, Ill.

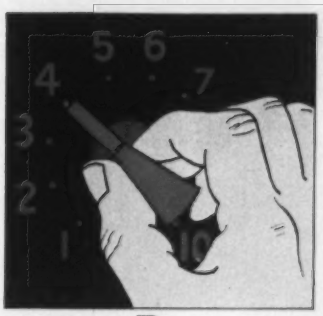
Circle 442 on Page 35



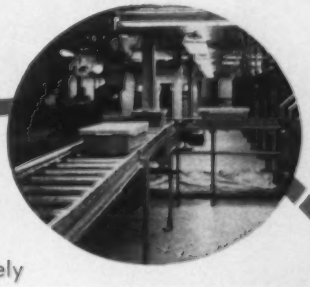
Fluctuation Adapter

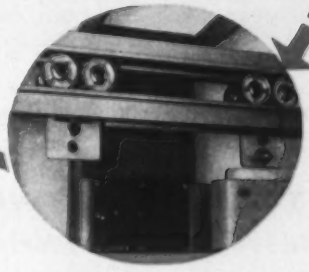
This device has been developed to continuously compute the magnitude of fluctuation of any process variable. It continuously reads a fluctuating 0.000 to 0.500 v ac input from any Autronic primary transmitter, computes the magnitude of fluctuation, and transmits a signal proportional to the magnitude of any Autronic controller. The A41A/1 is useful in any dynamic process situation where the controlled level of one variable is dependent on the fluctuation magnitude of another. Working with appropriate controls, it will maintain a constant magnitude of fluctuation, regardless of quantitative variations in the level of the monitored variable. It is therefore suitable for any situation where the magnitude of fluctuation is more important than the actual value of the highs and lows reached by the variable or where the specific range

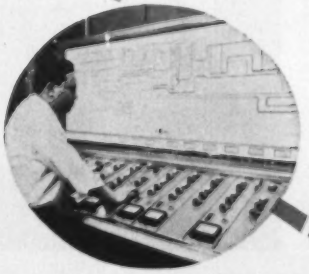
Circle 706 on Page 35



Controlling the movement in industry







For many years, Control Engineering Company has worked closely with conveyor equipment manufacturers. This close relationship has resulted in **system engineered** controls for specific applications. A CONTROLLED system will save on production costs, reduce lead time and increase handling efficiency.

Our complete line of **system engineered** controls, and our design experience — including modular construction, transistorized plug-in circuitry, feed back devices and servo devices — can be of help to you in planning your control systems.

Our CONTROL Engineers will be glad to consult with you on your particular **system engineering** problems.

Write today for free brochure describing our services.

CONTROL ENGINEERING COMPANY

A SUBSIDIARY OF JERVIS B. WEBB COMPANY

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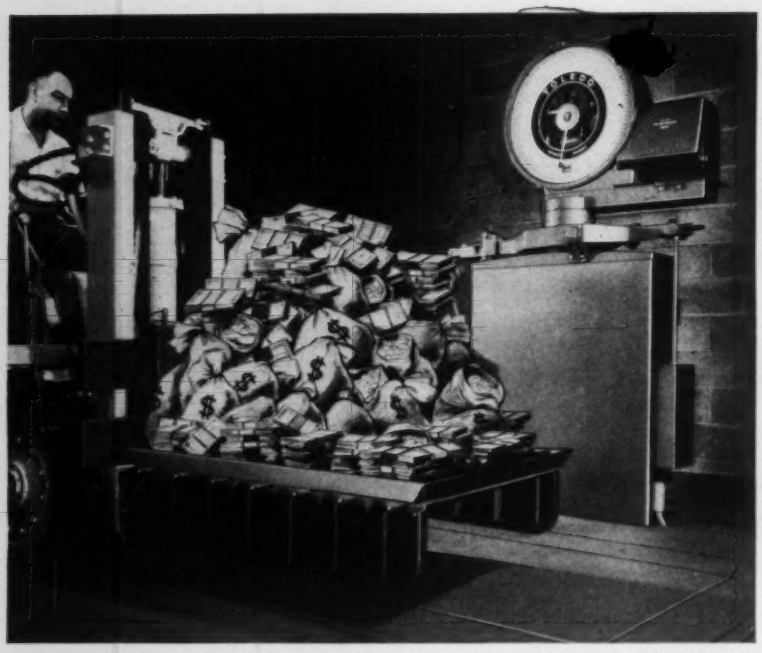
Circle 707 on Page 35



Why you should think of your scales as MONEY WEIGHING MACHINES

Cold, hard cash is the final value yardstick you must apply to every material or product that moves into, through, or out of your plant. How much does it cost? How much does it save? How much profit does it produce? In the last analysis, the answer always comes up in dollars and cents.

With dollars at stake, the *right* Toledo Scale at each weighing point is of the *utmost importance* . . . the backbone of control your needs demand. Your Toledo representative will take a personal interest in helping you get all the benefits provided by advanced Toledo methods and equipment. Write today. Toledo Scale, Division of Toledo Scale Corporation, Toledo 12, Ohio. *(Toledo Scale Company of Canada, Ltd., Windsor, Ontario.)*

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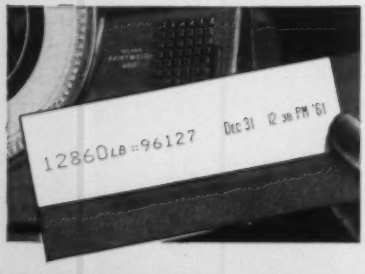
provides complete printed weight records



Prints where you wish on full 8½" x 11" forms, or on tickets or strips. Prints full figures, even when unit weights are used. Positive weight identification, with selective numbering, weight symbols, or consecutive numbering. Also prints time and date, if required. Weight data may be transmitted electrically to remote adding or other office machines. Ask for Bulletin 2017.

SERVICE Factory-Trained 240 Cities

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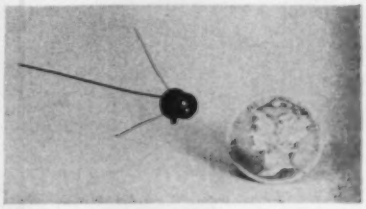
Headquarters for Weighing Systems

is regulated by other controllable variables or design of the process itself. **Swartwout Div., Crane Co.,** Hooksett Industrial Park, Manchester, N. H.

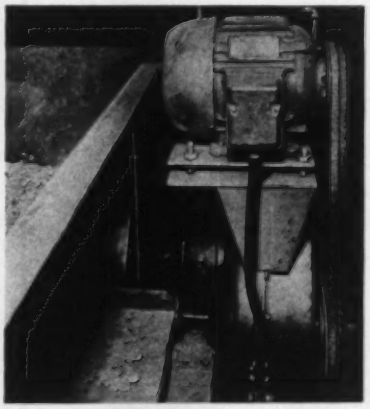
Circle 443 on Page 35



Photocell

Highly efficient light-actuated silicon switch has a very high impedance (over 10 megohms) when *Off* and a very low impedance (under 10 ohms) when triggered on by light. Its output is determined primarily by the load and is independent of light input at all intensities above the triggering level. The Photran can deliver up to 300 ma load current at up to 200 volts with an efficiency exceeding 98 per cent. This output often allows direct actuation of a load without intermediate instruments. Applications of this unit include counting, sorting, power control, limit switching, programming, and optical logic control. **Solid State Products Inc.,** Salem, Mass.

Circle 444 on Page 35



Motor Mounts

All-steel Equi-Poised motor mounts have been developed for mounting motors directly to the steel frame of a line of shaft mounted, flange mounted, and screw conveyor

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Air and Hydraulic

CONTROL VALVES

Whatever the application . . . whatever the service . . . whatever the pressure range . . . whatever the size . . . whatever the actuation required . . . chances are you'll find a valve in the Hunt line *exactly* suited to your needs.

Sizes range from ⅛ through 8 in. for vacuum to 300 psi air and for water, soluble oil and water, or oil to 5000 psi.

Your nearby Hunt representative will be pleased to work with you. You'll find him listed in Sweet's Product Design File.

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

For more information, write for Bulletin 603. Address Dept. AU-861, Hunt Valve Company, Salem, Ohio.

3001

Circle 709 on Page 35

American Hoist

SAVES SIX HOURS PER WELDMENT

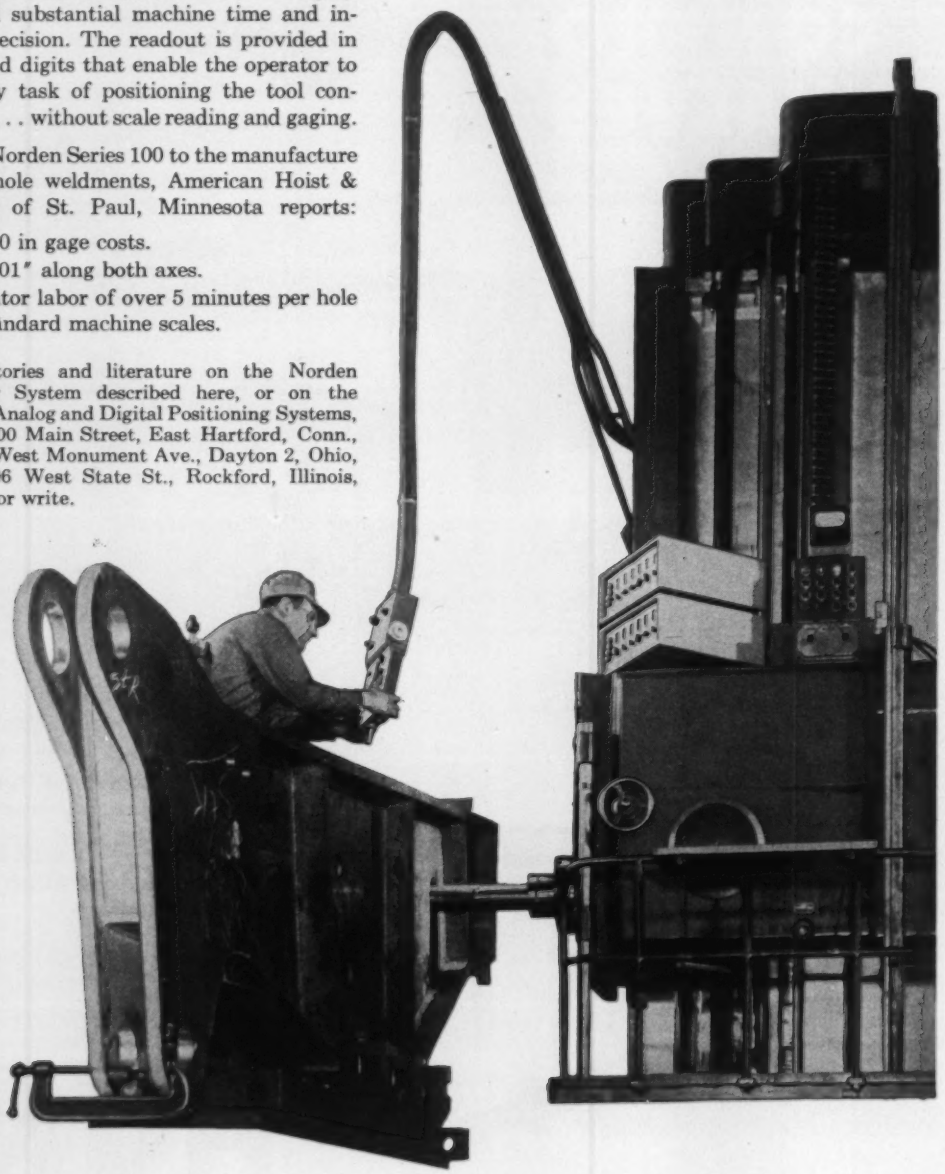
with Norden's Series 100 Modumatic Position Display System

American Hoist's costly, complex weldment structures must be precision bored along both sides of their 16-foot length. Equipping their 7″ Gray Boring Mill with two of Norden's Series 100 Modumatic Display Systems has saved substantial machine time and increased product precision. The readout is provided in six large illuminated digits that enable the operator to accomplish the key task of positioning the tool confidently, smoothly . . . without scale reading and gaging.

In applying the Norden Series 100 to the manufacture of these large 52-hole weldments, American Hoist & Derrick Company of St. Paul, Minnesota reports:

- Savings of $2,000 in gage costs.
- Accuracy to ±.001″ along both axes.
- Savings in operator labor of over 5 minutes per hole location over standard machine scales.

For other case histories and literature on the Norden Modumatic Display System described here, or on the Norden Modumatic Analog and Digital Positioning Systems, contact Norden at 400 Main Street, East Hartford, Conn., JAckson 8-4811; 11 West Monument Ave., Dayton 2, Ohio, BAldwin 8-4481; 206 West State St., Rockford, Illinois, WOodland 5-1891—or write.



NORDEN

division of UNITED AIRCRAFT CORPORATION

DATA SYSTEMS DEPARTMENT
3501 HARBOR BOULEVARD, COSTA MESA, CALIFORNIA

Circle 710 on Page 35

CUT PROCESSING COSTS

Automatic Thayer Scale Controls 3 Ingredients in Cranberry Sauce Processing, Cuts Handling Costs and Increases Profits.

Costly, time consuming measuring, feeding and blending operations in the making of cranberry sauce have been mechanized with 1 Thayer Scale. Now a Thayer Metering Scale continuously feeds cranberries, at precise rates, to the cooking process. In addition, the scale automatically controls the 2 other ingredients required, resulting in better product quality and uniformity at lower handling costs.

Unlike conventional scales, the Thayer Scale has no knife edge pivots to wear and cause inaccurate weighing. The Flexure-Plate suspension system of the Thayer Scale cannot wear, requires no maintenance, and accuracy is guaranteed for millions of weighings.

Thayer engineers will inspect your product and production process and demonstrate how your costs can be reduced by more accurate weight control.

Write for information on BAGGING, BATCHING, METERING and CHECKWEIGHING SCALES.

THE Thayer SCALE

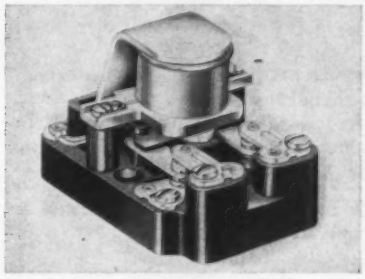
THAYER SCALE CORP.

3 Thayer Park
Pembroke, Massachusetts
TAylor 6-2371
A Subsidiary of Sundstrand Corporation

Circle 711 on Page 35

drives in the ½ to 30 hp range. These weldments are predrilled to accommodate all rerated NEMA foot-mounted motors within the rated capacity of the reducers. Used with shaft mounted drives, balanced design results in zero reaction from belt pull at headshaft bearings, thus actually reducing bearing loads on the driven machine. Adjusting screws provide a quick and convenient method of tensioning V-belts. **Falk Corp.**, Box 492, Milwaukee 1, Wis.

Circle 445 on Page 35



Power Relay

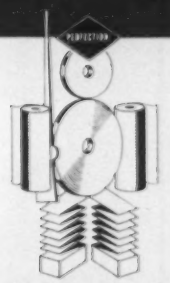
Power relay, designated Series 2300, is compact and features an inverted coil. It is designed to conform to strict space limitations. D.P.D.T. contacts are UL rated for 15 amperes at 115 vac noninductive, or 1 hp at 115/230 volts, 60 cycle. Easily accessible screw-type terminals can be connected from top or bottom. The relay is available in voltages of 6, 12, 24, 115, and 230 vac and 6, 12, 24, 110, and 220 vdc. **Guardian Electric Mfg. Co.**, Dept. 72-G, 1550 W. Carroll Ave., Chicago 7, Ill.

Circle 446 on Page 35

Digital Delay Generator

Unit has been designed for accuracy and precision in generating and measuring time intervals in electronic component testing. It can

FOR
Telecommunications
AND
Data Processing



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ARE YOUR PROTECTION

Whether your needs are for multi-channel data processing tapes (plain or colored); telecommunication papers; adding machine rolls, or somewhere in between, products trade marked PERFECTION provide top end results—insure consistently superior operation from your machines. That's because *every* lot of paper is tested to *rigid* specifications.

Specify Perfection Rolls for—

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DATA PROCESSING EQUIPMENT*
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Circle 712 on Page 35

"TIC-TOCK AROUND THE CLOCK"...

PDC Air-operated Toggle Action Press Head Shown

Standard risers available to increase shut height

PDC-EMUC-15 Electric Drive Index Table

PDC
"AUTOMATIC"
DIAL ASSEMBLY PRESS
... Range to 6 Tons

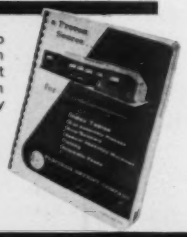
A PROVEN FACT: the PDC Automatic Dial Assembly Press *increases* production and *lowers* costs, and has proven itself in production for many years. It can be either hand-fed or hopper-fed.

This Standard Dial Assembly Press is for operations such as

• Assembling • Staking • Riveting
• Pressing • Forming

This machine can also be furnished with spinner heads, rivet hammers, punch presses and many other types.

Write TODAY for new Catalog 60, for designers and engineers.

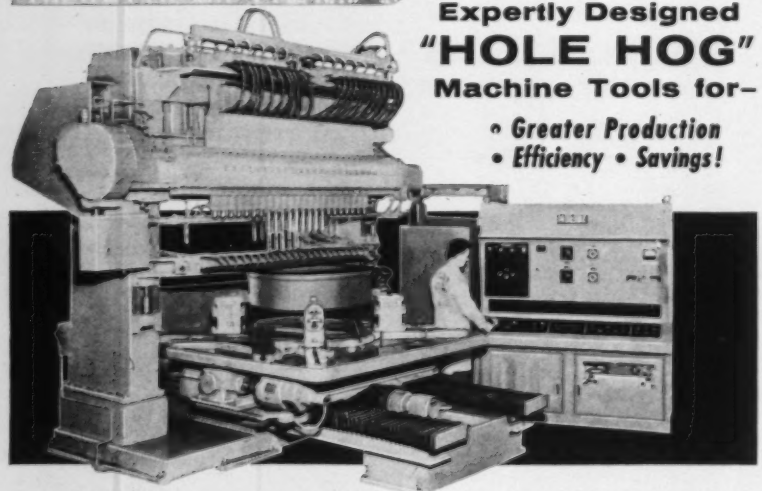


PRECISION DETROIT COMPANY
20100 SHERWOOD • DETROIT 34, MICHIGAN

Circle 713 on Page 35

MOLINE
MULTI-NUMETRIC
NUMERICAL CONTROL
(AS APPLIED TO MULTIPLE SPINDLE DRILLING)

Expertly Designed
"HOLE HOG"
Machine Tools for—
• Greater Production
• Efficiency • Savings!



MODEL HD68 Tube Sheet Drilling Machine with Multi-Numetric Numerical Control for positioning of machine table in two directions and for selection of spindles. Information on punched tape permits automatic drilling of a complete hole pattern in a tube sheet without interruption.

68 years of Machine Tool Engineering Experience is at your service for—

• Multi-Spindle Boring • Single and Multi-Spindle Honing
• Straight Line Multi-Drilling • Adjustable Spindle Drilling
• Special Multiple Operation Machine Tools

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115

MOLINE TOOL CO.

MOLINE TOOL COMPANY
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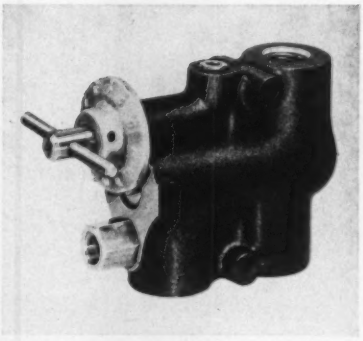
REPRESENTATIVES IN PRINCIPAL CITIES

Circle 714 on Page 35

be used as a radar simulator, secondary frequency standard, frequency divider, and many similar functions. Organizations working with radar, pulse circuitry, digital computers, and navigational electronics may use this precision digital delay generator as an essential addition to their laboratory facilities. Digital circuitry and crystal controlled stability of 1 part in 1 million permit accuracy of better than ±0.003 microsecond in 1000 microseconds. **Electronic Designs,** 2311 Farrington St., Dallas 7, Tex.

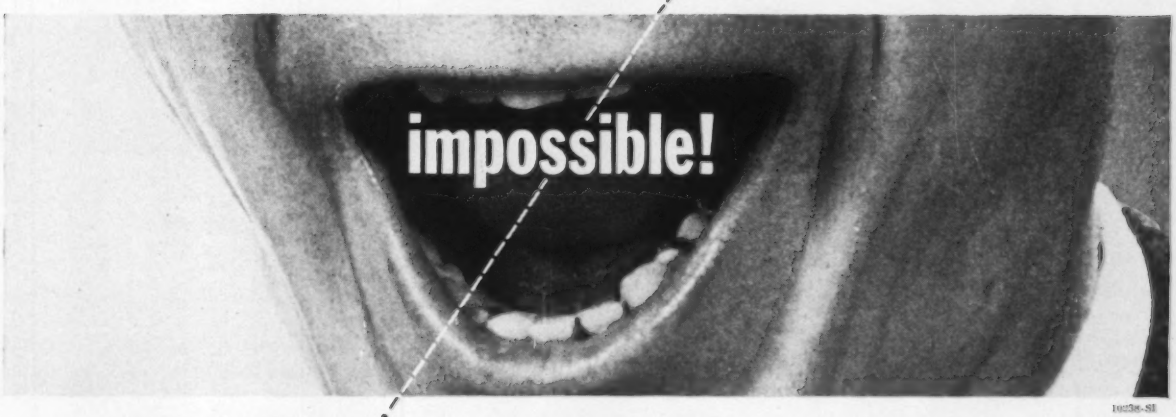
Circle 447 on Page 35



Flow Divider Valve

Valve was developed to simplify the control of hydraulic systems utilizing motors to operate conveyors, spreaders, reels, and other rotating mechanisms. Systems incorporating the Dial-A-Flow valve are operated by pressure compensated controlled flow. Principal design feature of the valve is a manually operated, detent positioned indicator dial that permits selection of up to 10 different rates of flow from a constant delivery pump. The dial can be set to provide accurately calibrated increments of controlled flow to meet specific capacity requirements of any motor. It can also be adjusted to suit varied operating conditions. Flow rate is adjustable from 0 to rated capacity. Fluid in excess of the amount delivered to the valve's controlled flow port can be used to operate another completely independent system at higher or lower pressure with no effect on the controlled system pressure or flow rate. Two sizes are available. Controlled flow of the smaller unit ranges from 0 to 15 gpm with rated input of 15 gpm. The larger valve controls up to 60

36,763* molds per hour?...



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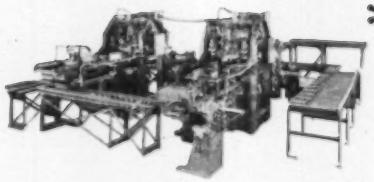


* THE FIGURE IS RIGHT...

AND ACTUALLY QUITE CONSERVATIVE!

The identification trade mark of SPO states that this organization is the "World's largest supplier of mold-machines." This is not just another advertising claim. There are SPO machines operating all over our globe . . . in almost every country. At this moment, men of every race, creed and color . . . and speaking virtually every language and dialect in the world . . . are producing molds on machines bearing the name SPO. It is our conservative estimate that MORE than 36,763 molds will be produced in THIS hour.

Our leadership has been earned . . . earned through long years of devotion to the industry and applied skill within individual professions comprising the entire field of metals. In foundry molding systems, our technological advances resulting from creative engineering, have established new horizons of molding progress.

SPO leadership will not go unchallenged . . . however . . . we propose to continue our dedication to progress. We will continue to improve our creative engineering services so that we can continue to supply versatile, efficient, economical "packaged" systems to meet every molding requirement, including Turnkey facilities.

WORLD'S LARGEST SUPPLIERS OF MOLDING MACHINES

SPO

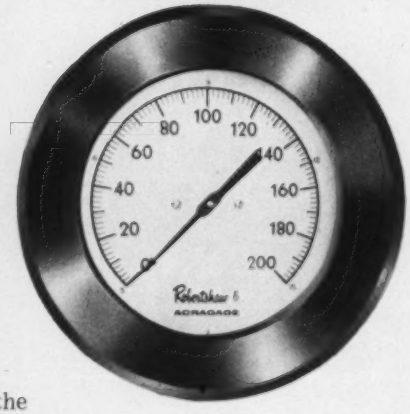
SPO INCORPORATED
6306 Grand Division Ave.,
Cleveland 25, Ohio

THERE'S A **SPO MACHINE** FOR EVERY MOLDING JOB

Circle 715 on Page 35

ACRAGAGE®
PNEUMATIC TRANSMISSION SYSTEM

For Instant, Accurate Remote Pressure Readings !



Whatever your pressure control application, here's the team that gives you instant, *centralized* reading from any desired number of remote points.

Both transmitter and receiver are offered in a variety of ranges to answer every need, requiring but a 20 psig air supply to deliver instant readings within ½ of 1%.

Simply and ruggedly made, Acragage sets a record for low-cost maintenance and high-level efficiency.

Send today for Catalog PK-G . . . for complete specs, price and other information on Acragage transmitters, receivers and complete transmission systems. First in performance . . . and built to last.

Robertshaw

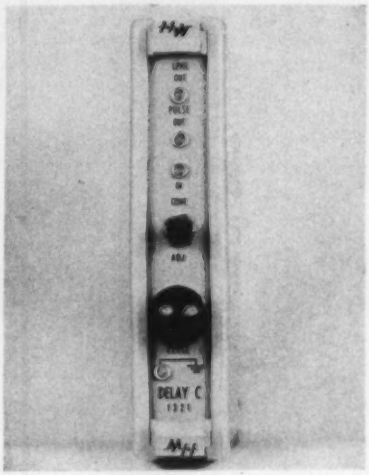
MR. CONTROLS

Robertshaw-Fulton Controls Company

FULTON SYLPHON DIVISION, KNOXVILLE 1, TENNESSEE

gpm with 80 gpm rated input flow. **Hydraulic-Electronic Div., Fawick Corp.**, 9919 Clinton Rd., Cleveland 11, Ohio.

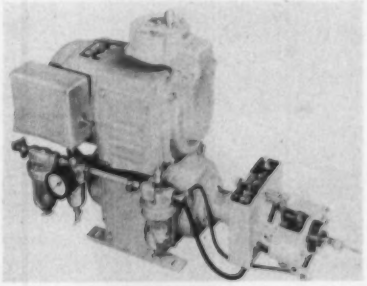
Circle 448 on Page 35



Logic Module

Dual-output variable delay logic module is available for use in digital systems where adjustable and/or long delays are required. Model 1321 Delay C is variable from 0.1 microsecond to 0.7 second in 5 incremental steps by means of a front-panel selector, and continuously variable between steps by means of a front-panel vernier control. A level output and a pulse output are always available to provide maximum versatility in the use of this unit. **Harvey-Wells Electronics Inc.**, 14 Huron Drive, Natick, Mass.

Circle 449 on Page 35



Lead Screw Tapping Unit

Variable speed lead screw tapping unit is air operated and completely self-contained with motor, speed regulator, and lead screw. The stroke of the unit is built into

for drilling . . .

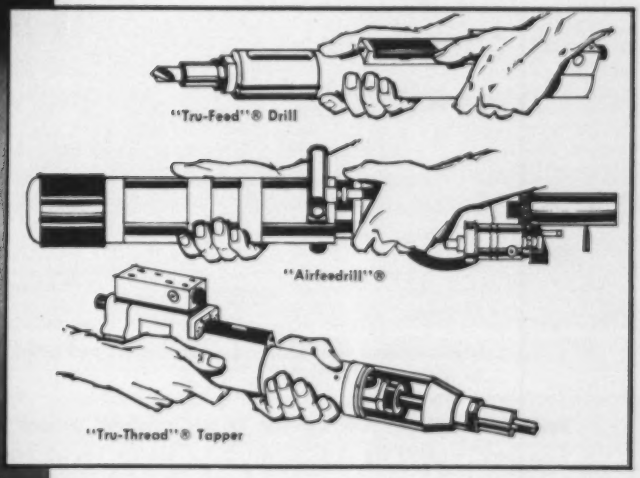
bring precision to these hands with the right air tools

For drilling one hole or hundreds, Gardner-Denver offers the right tools to get precision production from expensive hands.

Attachments for all types, all sizes of drills provide hundreds of uses for the basic air motor—assuring complete versatility and interchangeability.

Look at "Airfeedrill" units, for example. Mount 2, 20 or more for automatic drilling. Or just use one as either a stationary or portable drill.

For details on fast, precision drilling, see your Gardner-Denver air tools specialist, or write for bulletins.



GARDNER-DENVER Since 1859

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

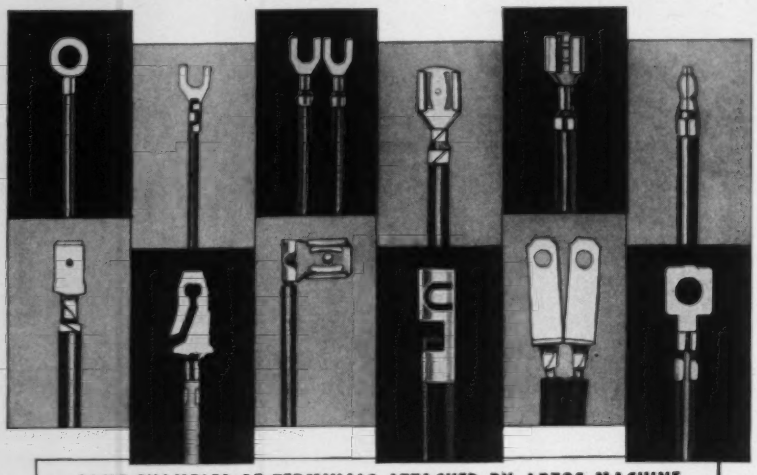
GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

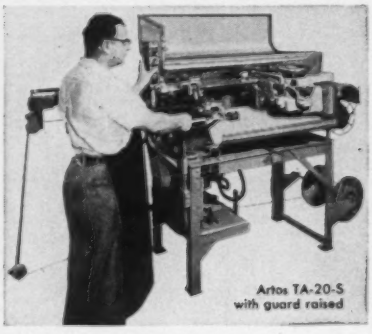
Circle 717 on Page 35

DO YOU NEED *Automation* FOR FINISHING WIRE LEADS WITH TERMINALS ATTACHED?



SOME EXAMPLES OF TERMINALS ATTACHED BY ARTOS MACHINE

NEW ARTOS TA-20-S Performs 4 Operations *Automatically!*



Artos TA-20-S with guard raised

1. Measures and cuts solid or stranded wire 2" to 250" in length.
2. Strips one or both ends of wire from 1/8" to 1".
3. Attaches any prefabricated terminal in strip form to one end of wire. (Artos Model CS-9-AT attaches terminals to BOTH ENDS OF WIRE simultaneously.)
4. Marks finished wire leads with code numbers and letters. (Available as optional attachment.)

PRODUCTION SPEEDS up to 3,000 finished pieces per hour. Can be operated by unskilled labor. Easily set up and adjusted to different lengths of wire and stripping—die units for different types of terminals simply and quickly changed.

ENGINEERING CONSULTATION . . . recommendations without obligation. Special adaptations made to fit requirements of your product. Machines for all types of wire lead finishing.

VISIT US AT BOOTH 4721 WESCON SHOW

WRITE for FREE Bulletin No. 655 on Artos TA-20-S

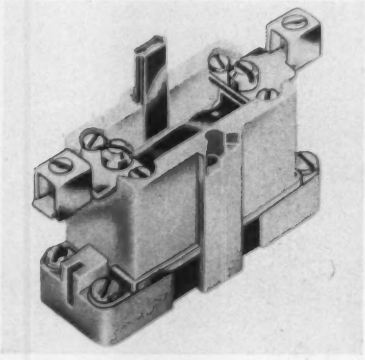
World Leaders in Automatic Machines for Finishing Wire Leads

ARTOS ENGINEERING CO.

2785 South 28th Street • Milwaukee 46, Wisconsin

the tapping head which functions by means of a lead screw assembly. Accurate depth stop holds uniform depth within 1/4 turn and provides uniform threads. Lead screws can be changed in seconds; lead screw nuts are adjustable for wear. Two lead screw tapping models are available: 1/2 hp unit has infinite speed range of 537 to 2150 rpm, a tap capacity of 0 to 1/4 inch, and length of stroke of 1 1/16 inches; 3/4 hp unit has an infinite speed range of 292 to 1170 rpm, a tap capacity of 1/4 to 3/4 inch, and length of stroke of 2 1/2 inches. Both models have heavy duty ball bearing motors. **Procunier Safety Chuck Co.**, 18 S. Clinton St., Chicago 6, Ill.

Circle 450 on Page 35

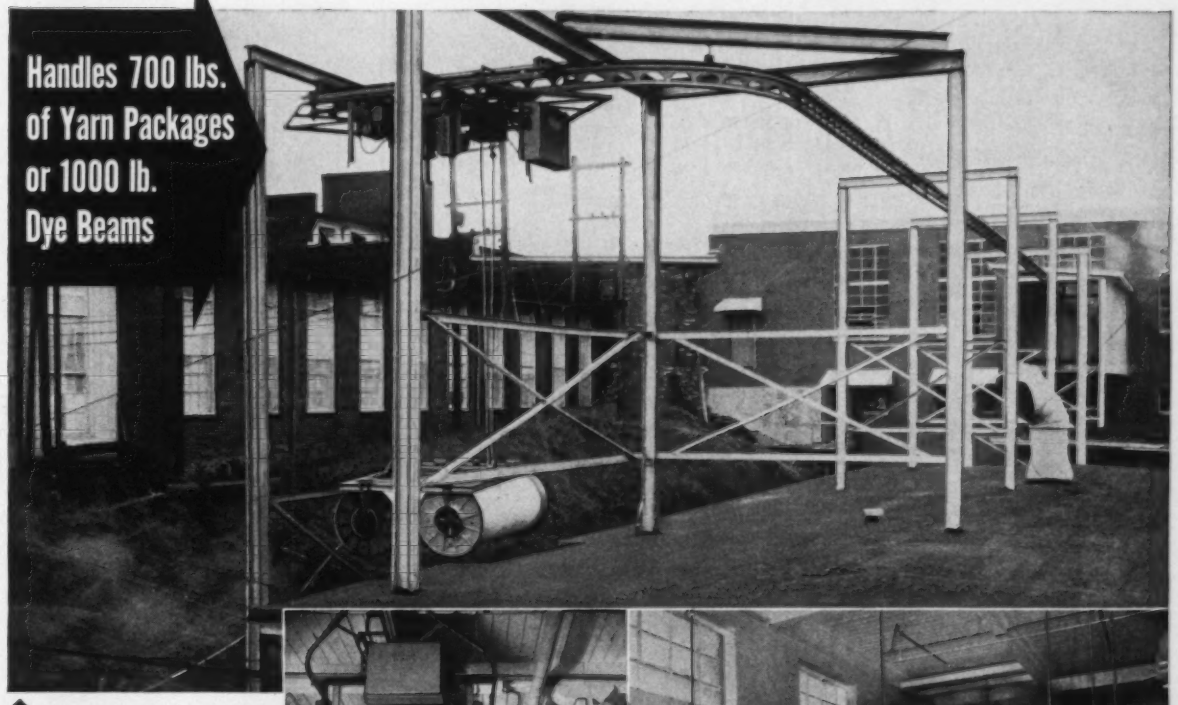


Overload Relay

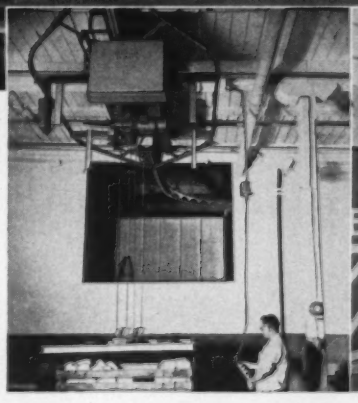
Relay compensates for both heat and cold, operating on the same time curve at all temperatures from −20 to +165 F. Compensation is completely automatic due to a balancing bimetal which is located in a separate compartment. Applications include control uses in outdoor installations subjected to wide seasonal or daily changes in ambient temperatures and for indoor control installations located near boilers, furnaces, heating units, or refrigeration equipment and subjected to wide daily changes in ambient temperatures. The relay has a calibrating screw that is set and sealed at the factory and permits precise setting for the exact current required. Available with a line of magnetic starters in NEMA sizes 0 through 5, this compensated overload relay is supplied in ratings from 25 to 300 amperes, continu-

Automatic Handling System Links *FOUR* Mill Areas

Handles 700 lbs. of Yarn Packages or 1000 lb. Dye Beams



Track installation on roof. Track entrance to Quilling Dept. is protected by an enclosure. At left warp beams are being lowered 65 ft. down side of Dye House to entry below ground level.



Starting a load of packaged yarn on way to Dye House from the Yarn Storage. The pushbutton station in the operator's hands has six buttons. Pressing any of the top three will send the carrier to one of the other three departments. The next two buttons are "up" and "down" for operating the hoist without traveling the unit. The bottom button is "stop" for the carrier travel.

Carrier traveling through Quilling Department and about to pass through doors for trip outside over roof. The doors are opened by bumpers on the carrier.

A Cleveland Tramrail automatic handling system at the Virginia Mills, Swepsonville, N. C., has eliminated manual handling between four main yarn-preparation departments: (1) yarn storage, (2) quilling department, (3) warper room, and (4) yarn dyeing. This mill spins a wide range of cotton yarns and many man-made fibers. It specializes in making drapery, upholstery and dress goods.

Although the building is multistory and the warper room is a floor above the yarn storage, the Tramrail system serves both areas and extends to the dye house a considerable distance away. To reach the latter, much of the track is on the outside over a roof, and the load must be lifted or lowered a distance of 65 feet. The overall length of the track is 266 feet.

Push button controls are provided at each of the loading stations in the four departments. By means of these controls, the Tramrail carrier can be directed to deliver a load from one station to any of the others. The unit travels without attendants and will stop at its destination automatically.

The automatic system has proven itself a tremendous factor in providing a smooth efficient flow of materials. No longer is it necessary for workers to haul heavy loads by manually pulled floor trucks for long distances. This advantage has brought about a big saving in time, as well as floor wear, and greatly reduced the need for floor trucks.

Write for free booklet 2008

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

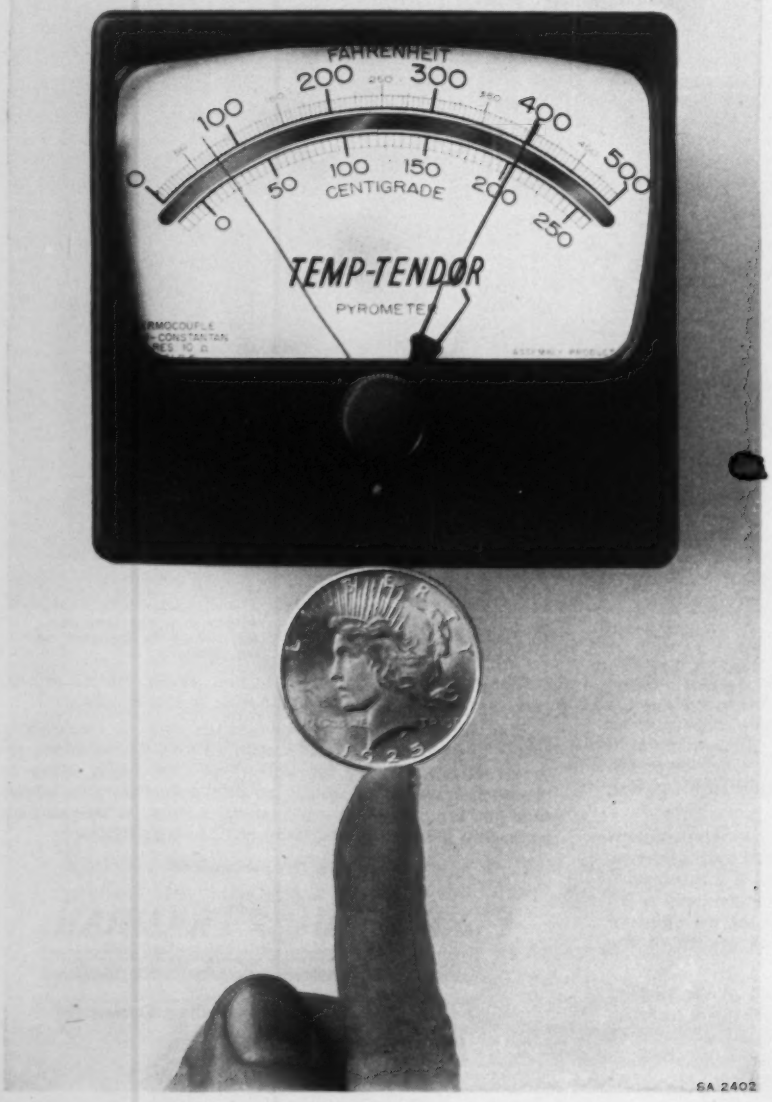
CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1386 E. 287 ST. • WICKLIFFE, OHIO

Circle 719 on Page 35

A NEW, SMALLER TEMP. CONTROL PRICED FOR THE OEM

Here you see, at about four-fifths actual size, A. P. I.'s new and handily compact temperature control, the Model 450 Temp-Tendor. It's a natural for "built-in" jobs. Measuring just 4" x 4¼" x 5½" overall, it's as easy to mount as a panel meter, requires no more than a meter-sized panel space. And it goes for a remarkably low OEM price. • For your money you get: a time-proportioning control capable of maintaining temperature to within ±1°F. of set-point, with built-in t/c length compensation adjustment, t/c break protection, fail-safe circuitry, instantly adjustable set-point, and a number of other features usually found only in instruments many times Temp-Tendor's modest size and cost. Available in eight standard ranges, from 0-300°F to 0-2500°F. Our Data Sheet No. 24 will give you detailed specifications. Drop us a line, and we'll put a copy in the mail.

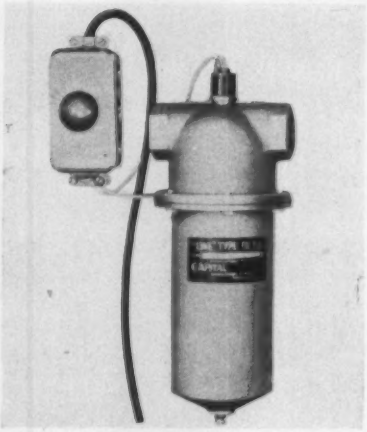
ASSEMBLY PRODUCTS INC.
CHESTERLAND 27, OHIO



SA 2402

ous current. **Industrial Control Div., Arrow-Hart & Hegeman Electric Co.**, 103 Hawthorn St., Hartford 6, Conn.

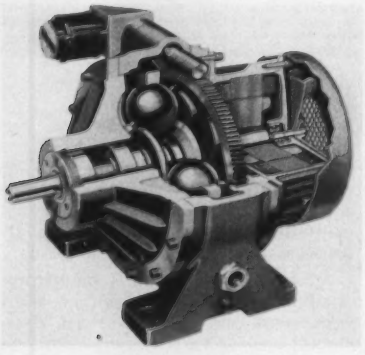
Circle 451 on Page 35



Filter Flow Meter

Hydraulic line-type filter flow meter is equipped with a built-in device that warns by illuminating a red light when liquid flow falls below a preset volume. It can be set to either turn on the light or to turn off the power supply until the filter is cleaned and replaced. A Guardian flow meter and filter protects machinery against costly damage. It can be used with any liquid. **Capital Engineering & Manufacturing Co.**, 5837 S. Ashland Ave., Chicago 36, Ill.

Circle 452 on Page 35



Motorized Speed Variator

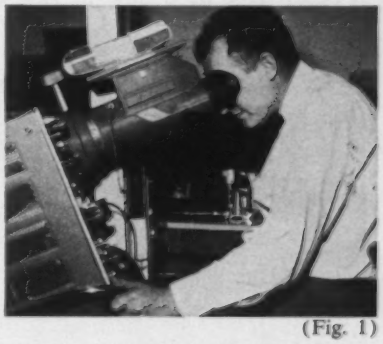
Motorized speed variator incorporates a motor with a mechanical variable speed drive. A pancake style motor is mounted on one side

Circle 720 on Page 35

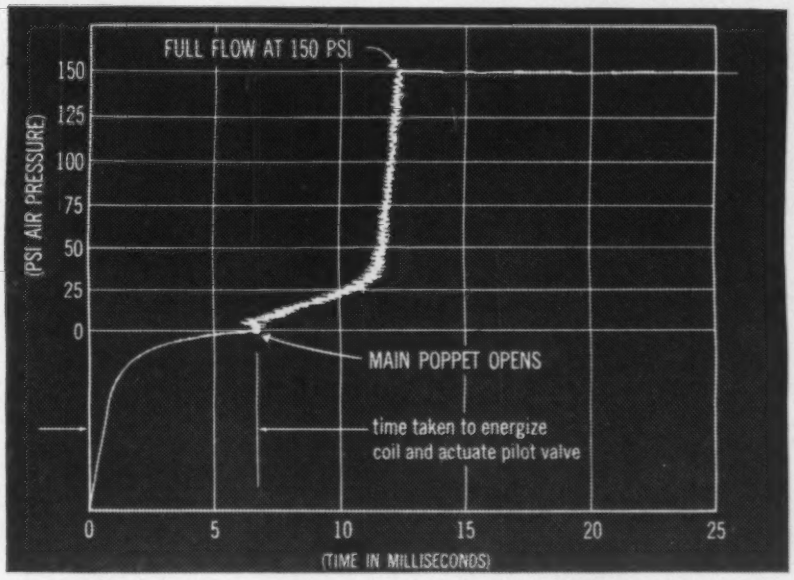
'Mach 2' Air Valve Gives 12 Millisecond Response

Oscilloscope tracks valve action from 0 to full flow at 150 psi

Twelve milliseconds is the time required to energize the solenoid coil, actuate the pilot valve, and bring the main poppet of a "Mach 2" air valve into fully open position at 150 psi. To record the instant response that eliminates lag in air-automated operations, a Crescent® "Mach 2" 4-way air valve was tested by the American Laboratory, Los Angeles, California. A camera located over the oscilloscope screen (Fig. 1) photographed the response action. Tests were made with a 12 volt DC coil in the de-energized position, poppet No. 1 in the closed position, and a system pressure of 150 psi. The graph (Fig. 2) was drawn from a photograph of the oscilloscope screen. The curved line in the lower section of the graph indicates the time required to energize the coil and actuate the pilot valve. The heavier line, above, is the oscilloscope's registration of the increase in pressure as poppet No. 1 moved from closed position to full open position where 150 psi line pressure was reached. Total elapsed time is 12 milliseconds.



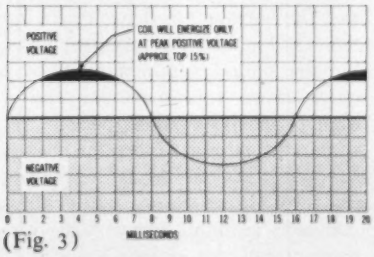
(Fig. 1)



(Fig. 2)

Corresponding results on AC current

Tests were run, also, on AC voltages and identical fast response was registered when coil actuation began at the positive peak of the AC sine wave. As indicated in Fig. 3, a wave length of AC current is approximately 16 milliseconds in duration. A coil will not energize until voltage has reached approximately 85% of capacity. The energized period represents 15% of the sine wave or 4 milliseconds. Therefore, additional milliseconds will be added to response time up to 12 milliseconds if the peak of the sine wave is not caught. Thus, the response time of a "Mach 2" air valve on AC voltage is from 12 to 24 milliseconds. This fast action is positive assurance against lag in operations where instant response is imperative – sorting, counting, discarding sub-weight containers, spot welding, etc.


POSITIVE VOLTAGE
COIL WILL ENERGIZE ONLY AT PEAK POSITIVE VOLTAGE (APPROX. TOP 15%)
NEGATIVE VOLTAGE
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
MILLISECONDS

(Fig. 3)

High speed PLUS dependability

The fast response of "Mach 2" air valves is attributable to original design advances that also dramatically improve endurance. These new air valves are rated at 1000 cpm continuous duty, and cycling speeds to 2100 cpm have been maintained for intermittent periods of 20 minutes. Control of coil heating and drastic reduction of friction in the solenoid and pilot valve sections are essential for this kind of performance. The extremely short stroke of the "Mach 2" solenoid plunger (3/32" – approximately the thickness of a nickel) fractions the time the coil is energized; heat generation drops and response is stepped up. Coil life is guaranteed for a minimum of 100 million cycles.

Friction drastically reduced

In the pilot valve, a tiny ball seats on "O" rings at both ends of a pilot cartridge. The ball moves freely, independent of the seals. There is no "O" ring drag on the pilot plunger because it requires no seals; where there is no friction there can be no wear. The main valve seats seal on "O" rings, and metal shoulders take the shock in such a way that the "O" ring seal is merely kissed by the seat in the sealed position. As the rings are only minutely flexed, they do not fatigue or lose their resilience.

PILOT CARTRIDGE

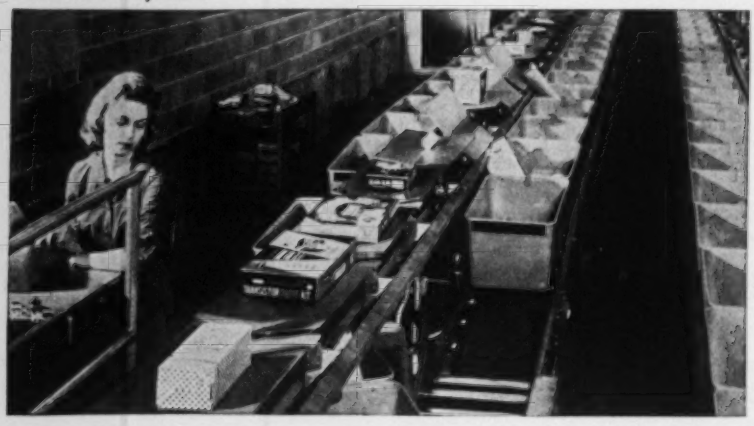
Write for your "Mach 2" catalog

The 12 millisecond response and long service life of "Mach 2" pilot operated air valves are sound recommendations for the installation of these field proven units. They are available in ¼" to ¾" pipe sizes. For your "Mach 2" catalog write to Barksdale Valves, 5125 Alcoa Avenue, Los Angeles 58, California.

"Mach 2" 4-Way Valve

Circle 721 on Page 35

This large Midwestern wholesale house uses four lines of QIK-TIP sorters to sort 12,000 pieces an hour to 400 destinations. The entire operation is easily done by a crew of 12 people. Further, the company has consolidated the operation of six separate warehouses under one roof and one modern system.



"QIK-TIP" SORTER

Automatically sorts and distributes up to 60 pieces a minute

The QIK-TIP Sortation System brings the advantages of modern, electronic automation to package handling in assembly plants, parts depots, warehouses, terminals and delivery services of all types. It cuts time, labor and the cost of human error to the bone. Here are two installations.

Write for descriptions of other applications or ask for a personalized analysis of your own sorting problem.

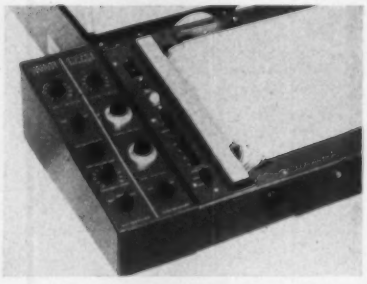
SPEAKER SORTATION SYSTEMS INC.

4535 No. 128th. St., Butler (Milwaukee), Wis.

By using the QIK-TIP Sorter, this large automotive parts warehouse increased order-filling speed so that orders are shipped the same day they are received. The stock picker places parts on the color-coded trays which tilt contents into chutes in the background.

of the frame of the basic drive. This line is available in 1/3 to 15 hp. Motors are of radial air gap design, conforming to NEMA Standard "B". The variable speed section of the motorized unit consists of a series of balls in contact with beveled drive discs, each splined to the two shafts. Infinite variations in speed over a range of 9:1 are possible by varying the circumference of contact paths on the input and output side of the balls. A torque responsive mechanism located between the shafts and their splined drive discs gives the variator a constant torque or constant horsepower capability. **Cleveland Worm & Gear Div., Eaton Mfg. Co.**, Cleveland, Ohio.

Circle 453 on Page 35

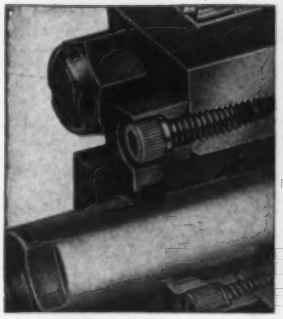


Tracking Accuracy Control

Designed to minimize spectra inaccuracies in frequency and band intensity, tracking accuracy control is used with IR-4 and IR-7 infrared spectrophotometers. It performs three functions—automatic slit control, automatic speed suppression, and automatic period suppression. Automatic slit control permits energy recovery by increasing the slit width when strong absorption by the sample, solvent, or atmosphere reduces energy to a point where instrument response lags. The speed suppression feature of the control automatically reduces scanning speed when narrow, intense bands are encountered and the wavelength drive is moving too fast for recorder response. Automatic period suppression gives a quiet curve in flat regions and a highly accurate short-period response in strong absorption bands by permitting the use of longer periods to reduce noise, while automatically reducing the period when beam unbalance exceeds a desirable

Circle 722 on Page 35

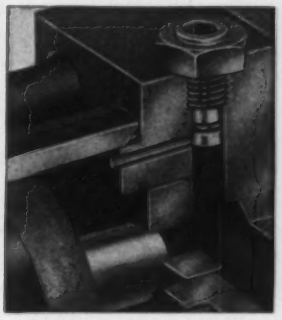
Do the cylinders you buy include these quality features?



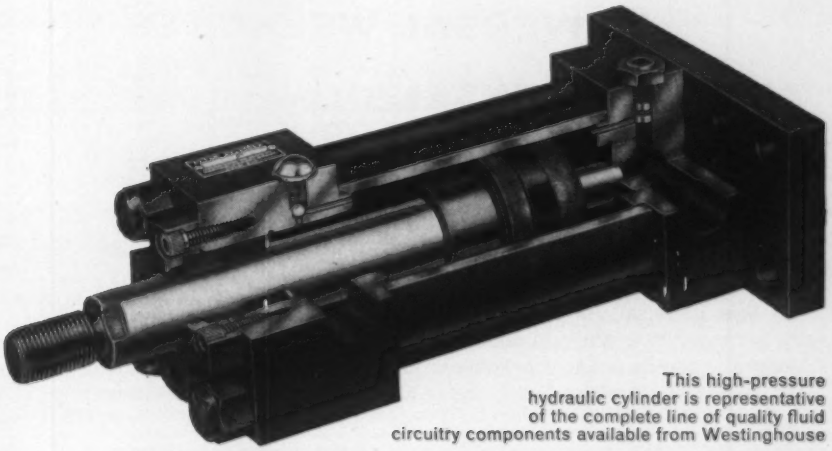
ROD GLAND—Easily removed. No need to loosen tie rods. Cuts maintenance time in half. Phenolic bearing insert will not score rod. Cuts replacement cost to a minimum.

ROD PACKING—Interlocking multiple lip seals require no adjustments; remain flexible under fluid pressure. Wear compensating function eliminates frequent replacement.

PISTON—Phenolic piston will not score tube. Packing cups used for proven long life and seal. Cups are easily replaced. Piston positively locked to rod.



CUSHION—Minimum clearance between piston and Meehanite Bushing combined with micrometer metering gives top cushioning efficiency and a wide adjusting range.



This high-pressure hydraulic cylinder is representative of the complete line of quality fluid circuitry components available from Westinghouse

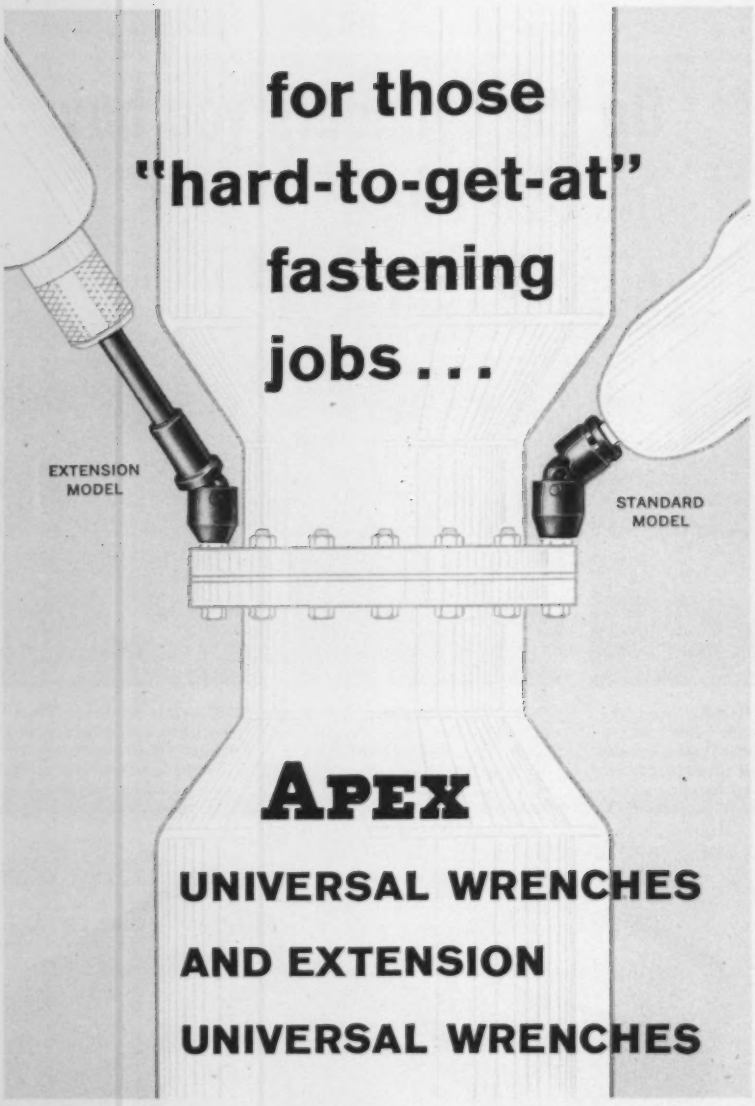
if not, the chances are, your maintenance costs are higher than necessary. For more information about Quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A3-56.00.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

Circle 723 on Page 35



An Apex universal wrench gives your power tool the flexibility needed to get right on fasteners located deep down where operating space is limited . . . even makes it possible to work around obstructions. Meets all safety requirements, will not bind or lock, even at maximum operating angle.

There are 1,268 types and sizes of Apex universal wrenches and extension universal wrenches among the more than 7,000 stock types and sizes of Apex fastening tools, each one developed to help reduce your fastening costs. In addition, we'll quote promptly on specials.

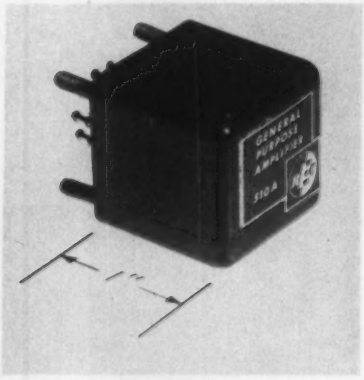
CATALOG 30-A—Nut Running Tools to ⅜" Drive.
CATALOG 30-B—Nut Running Tools over ⅜" Drive.
CATALOG 30-C—Screwdriving Tools.
CATALOG 30-D—Special Fastening Tools.

APEX FASTENING TOOLS
SCREWDRIVING • NUT RUNNING • SPECIAL
The APEX Machine & Tool Co. • 1036 So. Patterson Blvd. • Dayton 2, Ohio

Circle 724 on Page 35

level. Beckman Scientific & Processes Instruments Div., Beckman Instruments Inc., Technical Information Dept., 2500 Fullerton Rd., Fullerton, Calif.

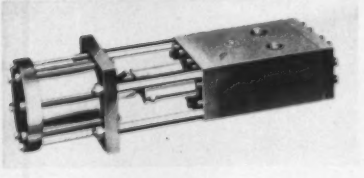
Circle 454 on Page 35



Transistorized Modules

Cubic circuit modules were designed for use as basic electronic design components. All units are suited to high temperature (−55 to 125 C) and high environmental (MIL-E-5272 and MIL-E-8189) use. Silicon transistors and diodes are utilized throughout. Modules available are general purpose amplifier with 40 db voltage gain (illustrated); high impedance input amplifier with 20 db power gain; power supply with 117 volts, 400 cps input and 20 volts regulated dc, 10 ma output; and rectifier-filter with two separate full wave rectifying and filter circuits rated at 30 volts dc each. **Rosemount Engineering Co.**, 4900 W. 78th St., Minneapolis 24, Minn.

Circle 455 on Page 35



Hydraulic Control Valves

Series of lever or pilot operated dual sealing type 2-way hydraulic control valves are especially suited for use in hydrostatic testing of tubing, pressure vessels, and similar items. The valves are capable of holding rated pressure in both di-

33% fewer components!

Traverse speeds up to 1000" per minute!

Accuracy unaffected by age, wear or temperature!

No shift registers or memory storage!

Manual and tape input!

Easy to program!

Easy to maintain!

THIS IS SPERRY...

The **VERSATILE CONTROL**

For your numerical control application, here at last is a truly versatile control, with *adjustable* speed and accuracy to fit almost any operational need.

THE MEASURING SYSTEM:

The initial accuracy of a Sperry Control continues throughout its life. Precise linear transducers used are unaffected by temperature, age or wear. These transducers are mounted parallel to machine motion, and do not rely on lead-screws, racks, pinions, or other mechanical devices.

THE DRIVE SYSTEM:

Sperry Controls employ an exclusive electro-hydraulic servo valve of simple design, without linkages, springs or 'dither impulse'. The valve accurately controls hydraulic motors or cylinders. Most machines with Sperry systems offer high speed cylinder drives which eliminate expensive and hard to maintain ball screws.

THE INPUT SYSTEM:

The Sperry Control uses EIA standard 1" 8-track paper or mylar tape and EIA standard coding. The pneumatic block reader provides one two co-ordinate position and auxiliary commands in only .1 second. Air pressure keeps the tape clean and eliminates reading errors due to brush or contact contamination. For short or simple programs, manual input switches are provided as standard equipment.

More systems application data for your particular machine or process may be obtained from:

SPERRY

SPERRY GYROSCOPE COMPANY OF CANADA, LTD.

P.O. Box 710, Montreal 3, Que.

Circle 725 on Page 35

Step-up Production Line EFFICIENCY with Wagner-Sangamo industrial Tachographs

Systems are available with speed reducing or increasing gears—with 12- or 24-hour disc charts or with 31-day strip-type charts.

Use these precision recording devices anywhere that the control of speed, time and measurement is essential to the quality of your products. They tell you how fast and long a machine is used . . . let you measure output versus time . . . fit in perfectly with quality control and time study programs . . . graphically record operation of one machine or entire automated line to help you determine production peaks and valleys, and non-productive time.

Consult your nearby Wagner Sales Engineer, or write us about your production recording problem. Wagner engineers will tell you if Tachographs will help you increase production efficiency.

W160-1

Wagner Electric Corporation

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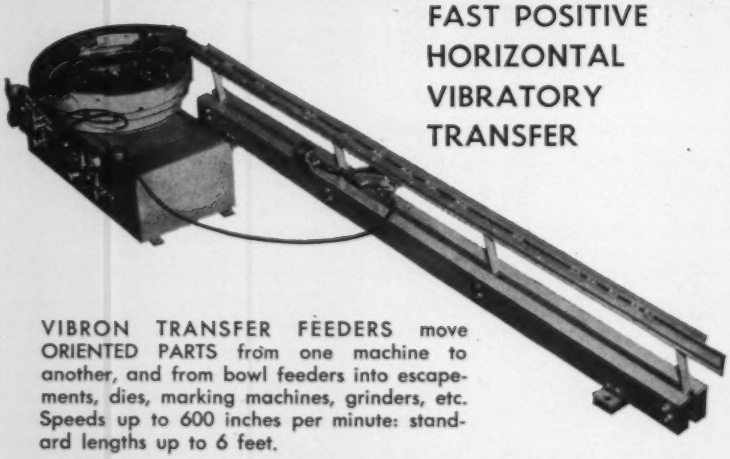
Circle 726 on Page 35

VIBRON TRANSFER FEEDER

FAST POSITIVE HORIZONTAL VIBRATORY TRANSFER



VIBRON TRANSFER FEEDERS move ORIENTED PARTS from one machine to another, and from bowl feeders into escapements, dies, marking machines, grinders, etc. Speeds up to 600 inches per minute: standard lengths up to 6 feet.

U. S. PAT. & PATS. PEND.

BURGESS & ASSOCIATES, INC.

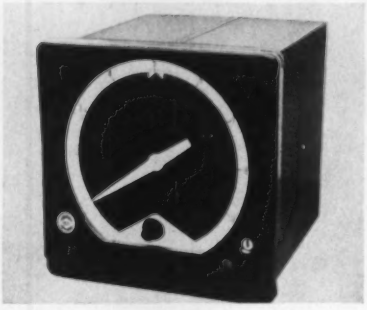
3790-A W. 150th Street Cleveland 11, Ohio

Telephone: ORchard 1-3825

Circle 727 on Page 35

rections. Valve U-packers face in toward valve ports. These valves are designed to release pressure on the packers, placing them in hydraulic balance, as the plungers shift. They are available in ½, ¾, 1, 1¼, 1½, and 2-inch sizes. Available pressure ranges are 2000, 3500, and 5000 psi. **Hunt Valve Co.**, 1913 E. State St., Salem, Ohio.

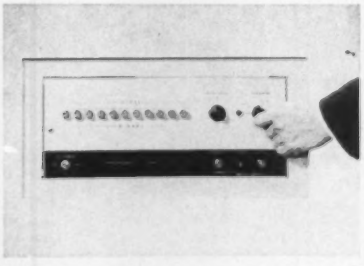
Circle 456 on Page 35



Indicating Controller

Pointer indicator and indicating controller is designed for use in any bonded strain gage transducer system. Designated as Type 110, this instrument can be used in systems using SR-4 transducers to measure weight, force, thrust, torque, and pressure. It uses a servo-driven slide wire to balance an internal bridge circuit. Thirteen standard models are available in pre-engineered packages to suit nearly any transducer measuring requirement. Standard models are capable of over-all system accuracies of ±½ per cent and special models can be provided to meet higher system accuracies. **Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.**, 42 Fourth Ave., Waltham 54, Mass.

Circle 457 on Page 35

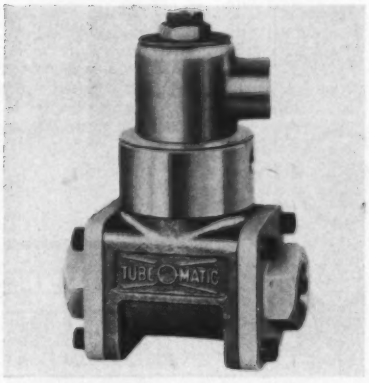


Solid-State Converter

Designated Digilog-1011 this solid-state converter is designed especially as a reliable input source for

computers, control systems, data logging systems, and storage systems. It produces a 10-bit binary output plus polarity indications. Output is serial or parallel. Voltage-to-digital conversion rate is 5000 conversions per second. A built-in trigger selector provides for conversions at lower rates. Digital-to-voltage conversion rate is 100,000 conversions a second. Control panel provides for visual monitoring of the 10-digit flip-flop switches and the stage of polarity in both binary and octal notations. The converter is designed for operation in temperatures ranging from 32 to 130 F. **Librascope Div., General Precision Inc.**, Glendale, Calif.

Circle 458 on Page 35



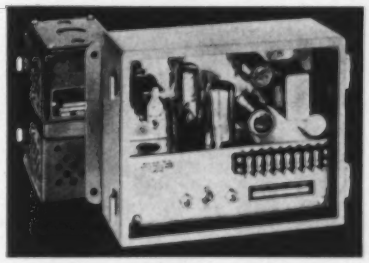
Pilot Operated Valve

Valve, designated Tube-O-Matic, has been designed to solve the problems of valve wear and maintenance in controlling abrasive and corrosive fluids and gases. The only moving part of the valve that is in contact with the media is a flexible rubber sleeve. These sleeves are available in a wide selection of alloys. The valve is available in sizes from ¼ to 2½ inches and 3 through 12-inches flanged. It is operated at a 1:1 pilot to media ratio. Maximum rating is 250 psi. **Airmatic Valve Inc.**, 7313 Associate Ave., Cleveland 9, Ohio.

Circle 459 on Page 35

Control Amplifier

Supersensitive proximity switch control amplifier permits standard sensing heads to be operated with



cable lengths of one foot to 60 feet. When used with any standard sensing head and connecting cable, it forms a complete proximity switch system. Model 4955D comes complete with a line voltage regulating transformer. It is available with or without JIC enclosure. Specific applications of the proximity switch system include: Detection of jar caps through cardboard, controlling shear for cutting metal, counting sheets on printing machinery, controlling automatic production lines, parts feeders, machine tools, food processing machinery, and conveyors. **Electro Products Laboratories Inc.**, 4500 N. Ravenswood Ave., Chicago 40, Ill.

Circle 460 on Page 35

GAGE PAGE

A Quick Run-down of New Gaging Ideas

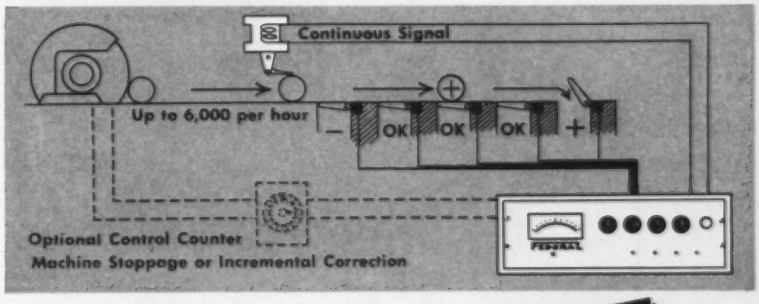
ELECTRONIC GAGING — *Economically*

Small Electro-Probe Gage Head for bench or automatic applications.

Highly versatile . . . Overtravel protected . . . Virtually frictionless response . . . Featherlight contact-pressure (less than 2½ grams) simplifies support design . . . Mounts in any position . . . Only 1½" x 2½" x 2¹⁄₃₂" thick . . . Impervious to oil and water . . . Works with variety of Amplifiers and combined Amplifier-Classifiers.

— for example 230M-27 (pictured) provides 8 gaging ranges . . . min. grads. from .000010" to .002" . . . Center zero meter . . . Four control limits which can be preset from panel . . . Classifies into five size categories, e.g. "over", "under", and three classifications of "good". — This precision combination for about $850.

Gage Head with dual-range Amplifier is less than $500.



For complete specs, dimensions — the *whole* story — send for Catalog 60 AM.

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1398 EDDY STREET, PROVIDENCE 1, R. I.

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FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging

Circle 728 on Page 35

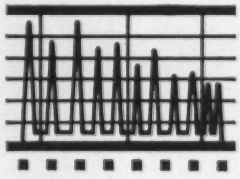
IF you want to control

and improve the quality of your product

with measurements displayed

on a dial . . . in an air column

or in signal lights

on a panel or a chart 

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Inspection Gages, Dimensional Control Instruments, Machine Controls, Automatic Gaging & Assembly Systems, Measuray® X-Ray Thickness Measuring, Crushtrue® & Multiform® Grinders, Cavitron® Ultrasonic Machine Tools, Press-Pacer® Transfer Units, Large Dies, Tooling, Contract Manufacturing.

AUTOMATION catalogs and literature

Latest automation information. For copies use card on page 19.

Batching Control Systems

Electronics Div., Fairbanks, Morse & Co., 505 Oakland Ave., West Hartford, Conn.—4 page pamphlet—An automatic batching control system especially designed for concrete and asphalt proportioning is subject of this bulletin. The Batchetron 600 control system utilizes load cells to weigh out preset amounts of material feeding into weigh hoppers. It follows a preselected sequence which can be repeated automatically. The system can use either a full electronic system or connect to a mechanical lever (Levetronic) system.

Circle 461 on Page 35

Induction Heating Units

Induction Heating Div., Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill.—6 two-page pamphlets—Features and equipment of six models of radio frequency heating units are described in Bulletins 1515 through 1520. The units are designed to convert powerline energy to high-frequency electrical energy suitable for induction heating of metals and other electrically conductive materials.

Circle 462 on Page 35

Electronic Relay

Monitor Controller Div., Atlee Corp., 99 Grove St., Rockland, Mass.—2 page pamphlet—Subject of this bulletin is an electronic relay, designated Model 3003. The relay is designed and built for exceptionally long life. Sensitivity is such that it will operate with ½ megohm in series with the contacts. Operating time is less than 0.05 second with 115 volt, 60 cycle power input. Applications include the control of electronic sorting systems and operation of signal or control equipment.

Circle 463 on Page 35

Vertical Machine Tools

Frauenthal Div., Kaydon Engineering Corp., Muskegon, Mich.—8 page bulletin—Bulletin 560 describes a line of vertical machines for precision standard and contour grinding, turning, boring, and other types of machining. It includes four standard series and production or specialized custom machines to meet individual requirements, with swings of up to 178 inches. Data are given on tracer or numerical control for these machines, standard features, optional equipment, and custom engineering services.

Circle 464 on Page 35

Data-Gathering System

Stromberg Time Corp., Subsidiary, General Time Corp., Thomaston, Conn.—8 page bulletin—Data are contained in Bulletin DS-2 on an automatic data-gathering

ADDENDUM TO AUTOMATION PRODUCT REVIEW

Here is an addendum to the May, 1961 AUTOMATION Product review. Specific information about these products can be had by circling the item numbers on an inquiry card on page 35 of this issue.

SPECIAL MACHINES—Automation Engineering Laboratory Inc. Company develops, designs, and produces new or improved machines, processes, and automated systems for industry. Working models are constructed so you can see your project operating in prototype within the first 15 per cent of your total expenditure.

Circle 490 on Page 35

COMPUTER SYSTEM—General Electric Computer Dept. Computer control system (Model GE-312) is adaptable to many types of applications in varying size plants. Its expansible memory has a capacity of up to 52,000 words, and its input/output is capable of scanning up to 1500 instrument inputs.

Circle 491 on Page 35

BORING MACHINE—Machinery Div., Ex-Cell-O Corp. Model 758 Numera-Trol machine automatically selects bore size and location. Using interchangeable boring bars which respond to tape control, variable bore diameters are programmed. Bore diameters are controllable within 0.0005 inch, bare depth is controllable to ±0.0005 inch, bore location is accurate within 0.0002 inch.

Circle 492 on Page 35

PHOTOCELL READER—Rheem Electronics, Div., Rheem Mfg. Co. Transistorized photocell reader uses silicon solar sensing cells. It reads punched tape at a rate of 100 characters per second. Eight information signals appear simultaneously.

Circle 493 on Page 35

VARIABLE SPEED DRIVE—Sterling Electric Motors Inc., Subsidiary, Hathaway Instruments Inc. Variable speed drive has sealed and shielded bearings that are factory-lubricated and require no lubrication. Since lubrication maintenance is eliminated, the drive can be installed in any location, no matter how inaccessible. Unit is available in a wide range of speeds, heavy duty iron case, and finger-tip control.

Circle 494 on Page 35

ASSEMBLY EQUIPMENT—Swanson-Erie Corp. Automatic assembly equipment includes complete machines or over 200 standard indexing machine chassis, ready for application to your own designs. All are built to the most exacting standards of quality and reliability and carry a guarantee of complete parts interchangeability.

Circle 495 on Page 35

DATA TRANSMISSION—Stromberg Div., General Time Corp. Data collection and transmission system gives complete data on production status and order location, inventory control, labor costing, tool crib and stores control, receipt and shipment, and on-line communications. Reports can be produced in minutes.

Circle 496 on Page 35

system, designated Transactor. This system serves as a rapid communication link between sources of original entry at multiple transaction points and a central data-processing office. By completing the communication loop, the system eliminates intervening manual operations. Typical applications include production control, inventory control, job order recording, job costing, and on-line communication. Bulletin illustrates various components of the system.

Circle 465 on Page 35

Spray Dryers

Bowen Engineering Inc., North Branch, N. J.—4 page pamphlet—Bulletin 37 discusses special-design spray dryers for pilot plant and hard-to-dry materials, and moderate-production dryers (up to 20 tons a day). Besides information on capacity, the booklet discusses specifications of air heating, chamber sizes and construction, atomization, duct arrangement, product collection, and accessory instrumentation. Erection information and details on space requirements are also covered. Bulletin includes photographs of dryers in actual plant situations.

Circle 466 on Page 35

Actuator Positioners

Hanna Engineering Works, Dept. PR-27, 1765 Elston Ave., Chicago 22, Ill.—10 page bulletin—Bulletin 500A shows how this line of electrical-mechanical positioners can be used to automatically position many types of mechanical devices, regulating machine tools, valves, floats, hoppers, throttles, etc. at any of several predetermined positions corresponding to a remote control selector switch signal. Illustrations, line drawings, and charts give specific information needed to figure ways of applying Hanna-Powr positioners to air-hydraulic power cylinders, motorized screw drives, and other regulating devices.

Circle 467 on Page 35

Overhead Conveyor Systems

Chainveyor Corp., 5618 E. Washington Blvd., Los Angeles 22, Calif.—collection of pamphlets—Data are contained in these booklets on a line of overhead conveyor systems. These conveyors run horizontally, straight up or down, upside down, and around standard curves of 16-inch radius. They feature an idler sprocket that enables lines to be returned on a 6-inch radius with parallel lines 12 inches apart. Applicable to all types of industry for handling loads up to 60 lb per foot, the conveyors have a tensile strength of more than 2400 lb under static load. Individual loads up to 120 lb may be carried on load-bar carriers. Typical conveyor installations are illustrated.

Circle 468 on Page 35

Controlled Volume Pumps

Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.—32-page catalog—Bulletin 553-2 contains data on a line of motor-driven controlled volume pumps with interchangeable packed or diaphragm liquid ends. Bulletin features a selection data guide, materials selection charts, and capacity-pressure selection tables. Photographs illustrate various available pump models.

Circle 469 on Page 35

Electroplating Processes

Hanson-Van Winkel-Munning Co., Church St., Matawan, N. J.—24 page booklet—Bulletin EP-102 gives brief descriptions of 18 electroplating processes including three nickel processes: Levelume 220, improved Levelume, Permalume, the latest semibright process that can be continuously carbon treated, and Superlume, a premium superbright, super high-leveling bright nickel bath. Conversion coating processes Chem-Rite A-22 for aluminum and Chem-Rite Z-33 for zinc are also described. Other processes covered are Cadalume, Copper-Lume, Nickel Sulfamate, Silver-Lume and Zincalume.

Circle 470 on Page 35

In-Line Checkweighers

Toledo Scale, Div., Toledo Scale Corp., Toledo 12, Ohio—8 page bulletin—Form 2968a illustrates and describes a line of automatic, in-line checkweighers capable of providing zone-edge tolerances from 1/32 oz to ½ oz depending upon size. Accuracies as high as 1 part in 12,000 are obtainable. Booklet provides details on checkweighing speed, accuracy, and weight range of each checkweigher model. Various industrial applications are illustrated.

Circle 471 on Page 35

Combustion Indicator

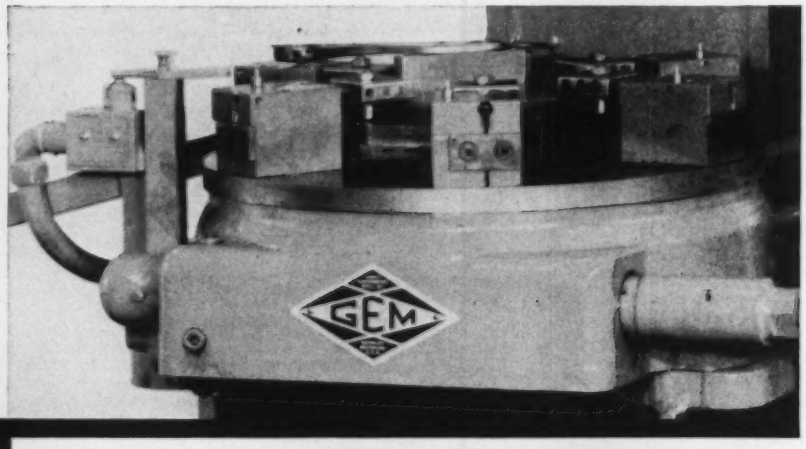
Selas Corp. of America, Dresher, Pa.—8 page bulletin—Bulletin Q-2 describes a continuous reading instrument, designated Qual-O-Rimeter combustion indicator, which accurately indicates changes in flame characteristics caused by variations in air/gas mixtures. Sensitivity is such

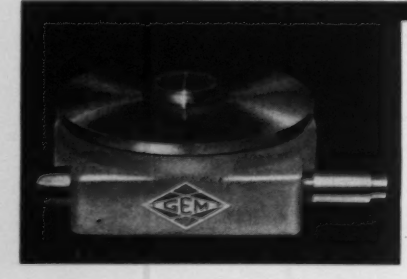
precision indexing to ±0.001"

. . . WITH GEM-17 DIAL INDEX TABLE!

FAST	Geneva motion smoothly positions in speeds up to ½ sec.
RUGGED	1000 lb. work load with solid anvil capacity of 30 tons.
POSITIVE LOCK	Bolt in Geneva slot cammed both in and out given positive locking.
POWER	Comes complete with rotary air motor, solenoid valve with limit switch (fluid or electric motors available).
NUMBER OF STATIONS	6, 8 or 12 standard, 3 and 4 skip.
SIZE AND WEIGHT	200 lbs. complete with 17" dia. table (plates up to 36" available).

GEM-17 mounted on GEM ATP-6, 6 ton toggle press with standard GEM base.





Geneva Motion GEM-17 Indexing Table standardizes automation on your assembly and machining operation . . . drilling, tapping, riveting, spinning, staking, knurling, chamfering, welding, screwdriving, stud driving and gaging to the speed and accuracy required. Gray's complete engineering staff can adapt the table to your work problem.

Send for Bulletin DI-17 and complete information.

gem

GRAY equipment company

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Circle 730 on Page 35

that this instrument can detect changes as little as ±5.0 Btu in fuel gas and ±0.5 per cent of air in air/gas mixtures. Response time is less than 5 seconds. Typical uses illustrated include brazing and soldering, heating for hot working, setting up multiple air/gas mixing machines, and glass fiberizing.

Circle 472 on Page 35

Portable Data Punch

Addressograph-Multigraph Corp., 1200 Babbitt Rd., Cleveland 17, Ohio—4 page pamphlet—Bulletin SP-40-A describes a portable data punch that prepares variable source data for direct input to punched card EDP systems. Device provides an accurate, low cost means for collecting machine and human sensible data on source documents. It handles various size tabulating cards or multiple-part card sets. Several models are described and illustrated.

Circle 473 on Page 35

High-Speed Photography

Wollensak Optical Co., 850 Hudson Ave., Rochester 21, N. Y.—4 page pamphlet—Bulletin F100 provides details on high-speed photography for studying actions too fast for the eye to resolve. Various applications are discussed. Two Fastax high-speed cameras are illustrated and their characteristics explained. Details are also provided on accessories such as a high intensity xenon lamp, a continuous automatic negative or reversal film processor, and a motion analysis projector.

Circle 474 on Page 35

Transmission Belts

Belting Div., Russell Manufacturing Co., Middletown, Conn.—4 page pamphlet—Ultraspeed and ultraspeed-M high-speed transmission belts are covered in this bulletin. Belts are 0.035-0.040 inch and 0.016-0.020 inch thick respectively. They are capable of operating successfully at speeds up to 145,000 rpm, on pulley diameters as small as ⅜ inch, and feature minimum tension and less than ½ per cent stretch during belt life. Belts can be used for either dry or oily drives.

Circle 475 on Page 35

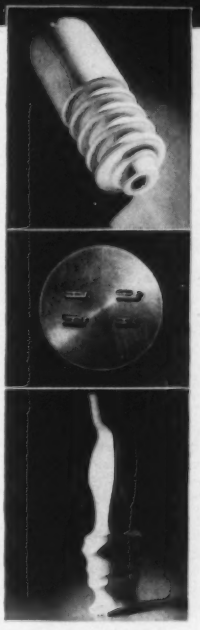
Lubrication Systems

Industrial Sales Div., Lincoln Engineering Co., 4010 Goodfellow Blvd., St. Louis 20, Mo.—36 page catalog—Catalog 82 covers a line of centralized lubrication equipment. It describes fully automatic, semi-automatic, and manual methods of operation. High and low pressure lubricant injectors, timing and alarm controls, and filler pumps are described along with installation accessories such as tees, hose, flexible feed lines, and coupling studs.

Circle 476 on Page 35

Gas Proportioner Systems

National Cylinder Gas Div., Chemetron Corp., 840 N. Michigan Ave., Chicago 11, Ill.—16 page booklet—Recently developed gas proportioner systems, which mix various gases at the point of application rather than having them mixed by the supplier, are diagrammed and discussed in



SENECA FALLS
single and two dimension
tracer systems

Seneca Falls offers two simplified, moderate-cost electromechanical tracer systems which will accept tape, template or dial input signals and automatically machine simple or difficult contours in any material that is machineable. Each has unique advantages not found in conventional tracer systems. Both systems have demonstrated their dependability and ease of maintenance in various rugged industrial applications.

These tracer systems are but two of many outstanding control systems and control components developed, designed and perfected in our Electronic Laboratories.

Bulletin EE1010 describes the tracer systems. Write for it, and if you have *any* control problem, give us the facts.

SENECA FALLS MACHINE
PIONEERS IN AUTOMATION

ELECTRONICS DIVISION
SENECA FALLS MACHINE CO., SENECA FALLS, N.Y.

Circle 731 on Page 35

Information Report No. 20. Intended for use by manufacturers whose operations require the use of compressed gas mixtures, the booklet covers manual, semiautomatic, and automatic systems. Proportioners which can supply varied mixture ratios are described, and developments of on-site proportioning equipment to fit particular needs is discussed.

Circle 477 on Page 35

Safety Switch

Fuller Co., Catasauqua, Pa. — 4 *page pamphlet*—Improved type motion safety switch for protecting machines, equipment, and processes against damage resulting from stoppage or reduced speed is described and illustrated in Bulletin MS-3. Design, installation, and operation of the switch are described, as well as typical applications. Two installation photographs and a cutaway drawing of the switch are included.

Circle 478 on Page 35

Punched Tape Reader

Westrex Corp., Recording Equipment Dept., 6601 Romaine Ave., Hollywood 38, Calif.—2 page pamphlet—A description of Model RA-1656 punched tape reader is contained in Bulletin 3.7. This unit can read punched tape at the rate of 1500 characters per second, and can stop on character at 500 characters per second. Complete specifications as well as a photograph of the unit are provided.

Circle 479 on Page 35

HANSEN

SERIES HK® QUICK-CONNECTIVE

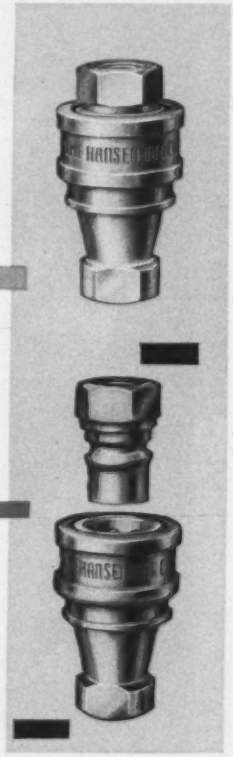
TWO-WAY SHUT-OFF COUPLINGS

QUICK FLUID LINE CONNECTION OR DISCONNECTION

WITH

INSTANT AUTOMATIC FLOW OR SHUT-OFF

Instantly shuts off both sides of line . . . prevents loss of liquid, gas or pressure



When Coupling is disconnected, identical valves in both the Socket and Plug provide instant shut-off of gas or liquid. To eliminate leakage or spillage during disconnection, the Coupling is so designed that shut-off takes place *before* the Plug separates from the Socket—and *before* the seal of the Socket itself, provided by the Socket "O" Ring, is broken.

In reverse, when Coupling is connected, the "O" Ring in the Socket completely seals Coupling *before* valves release flow of fluid from both sides of line—thus eliminating possibility of spurt of gas or liquid during instant of connection.

Available in brass or steel with female pipe thread connections from ⅛" to 1½" inclusive—also up to 1" in stainless steel.

Write for the Hansen Catalog

Here is an always ready reference when you want information on on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings — including Special Service Couplings for LP-Gas, Steam, Oxygen, Acetylene, etc.

Representatives in Principal Cities . . . see Yellow Pages

SINCE 1915 QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

Circle 732 on Page 35

Servo Valve

Machinery Hydraulics Div., Vickers Inc., Div., Sperry Rand Corp., Administrative & Engineering Center, Dept. 1400, Detroit 32, Mich.—2 page pamphlet—Single stage servo valve (Series SC4) for application in electrohydraulic servo systems is described in Bulletin 61-79. This valve is available with a choice of torque motor resistances compatible with electronic, magnetic, or transistor inputs. Flow rating is 3 gpm with 350 psi pressure drop. Typical response and flow curves are shown.

Circle 480 on Page 35

Pneumatic Tube Systems

Lamson Corp., Lamson St., Syracuse 1, N. Y.—40 page catalog—Data on a line of airtube systems are contained in this catalog. Various applications of the systems in distributing paperwork are discussed. Conventional, semiautomatic, and automatic systems are explained and illustrated in separate sections. A technical data section is directed to engineers and architects, and deals with the components of airtube systems. This section is illustrated with engineering drawings including design dimensions.

Circle 481 on Page 35

Metal Finishing Equipment

Meaker Co., Subsidiary, Sel-Rex Corp., Nutley 10, N. J.—36 page catalog—A wide range of machines and equipment designed to automate plating and metal finishing operations is described in Catalog 160. Featured are photographs of actual installations. The booklet provides data of interest to both large and small firms contemplating automation of these operations. Several tables show electrochemical equivalents of base and noble metals; data on depositing zinc, copper, tin, nickel, cadmium, and chromium; and electrical conductivities of different metals and alloys.

Circle 482 on Page 35

Photoelectric Cells

Photomation Inc., 96 S. Washington Ave., Bergenfield, N. J.—24 page handbook—Bulletin 611 covers all phases of photoelectric cell applications in automation. History and development details are provided. Illustrations and schematic diagrams show diversified photoelectric systems. Illustrations range from miniaturized light sources and photo units to time delays. A list of U. S. and foreign representatives is included.

Circle 483 on Page 35

Semiconductor Evaluator

Cook Electric Co., Public Relations Dept., 2700 Southport Ave., Chicago 14, Ill.—4 page pamphlet—Subject of this bulletin is an ACE-700 automatic component evaluator, designed primarily for transistor and other semiconductor measurements. This machine is readily adaptable to many other two or three-terminal network measurements because of the flexibility of its basic design. It accepts components in quantities up to a maximum of 50. Six basic measurement modules measure the following parameters: Saturation voltage, breakdown voltage, reach-

through voltage, reverse current, dc gain programmed collector current, and dc gain programmed base current.

Circle 484 on Page 35

Electric Assembly Tools

Black & Webster Inc., 570 Pleasant St., Watertown 72, Mass.—16 page booklet—Catalog 75-A provides information on a line of electric assembly tools. It explains how the equipment can be used for feeding, indexing, staking, swaging, riveting, punching, marking, and terminal setting. Details are provided on how the tools work as well as the different ways and areas in which they can be used. Accessories are illustrated and described.

Circle 485 on Page 35

X-Y Recorder

Houston Instrument Corp., P. O. Box 22234, Houston 27, Tex.—2 page pamphlet—Bulletin 792-5 describes an X-Y recorder that records one variable in terms of another. Featuring flat bed construction, standard 8½ by 11 inch paper size, and clip on pens, Model HR-92/93 is available with a variety of inputs and optional electric pen lifter. Completely mechanical and electrical isolation provides for no cross-talk between channels, and easy checkout.

Circle 486 on Page 35

Blending by Weight

B-I-F Industries, P. O. Box 276, Providence 1, R. I.—32 page handbook—Booklet entitled "It's a Fact" provides data on the problem of blending high and low voltatile coals to prevent excessive expansion in coke ovens. It describes the accuracy and economy of blending by weight and features a Conveyoflow Meter for weighing and controlling. Two-page data sheet and accompanying bulletins contain illustrations, schematic diagrams of a typical installation, dimensions, and a description of the operation, uses, and advantages of weight blending equipment.

Circle 487 on Page 35

Temperature Regulators

OPW-Jordan Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio—8 page bulletin—Catalog TCV-1 contains engineering information and technical data on a line of sliding gate temperature regulators available in self or pilot-operated models from ¼ through 6-inch sizes. It provides cutaway pictures, features, names of parts, ratings, dimensions, applications, etc. Also included are flow curve and sizing charts.

Circle 488 on Page 35

Fluid Power Cylinders

Lynair Inc., 3100 E. Michigan, Jackson, Mich.—58 page catalog—Data are contained in Catalog AH-8 on a line of pneumatic and hydraulic cylinders. Types of cylinders covered include: Square, low pressure hydraulic, air-hydraulic, air-to-air booster, high pressure hydraulic, and Series B air. Cut-away diagrams of the various available models are provided.

Circle 489 on Page 35

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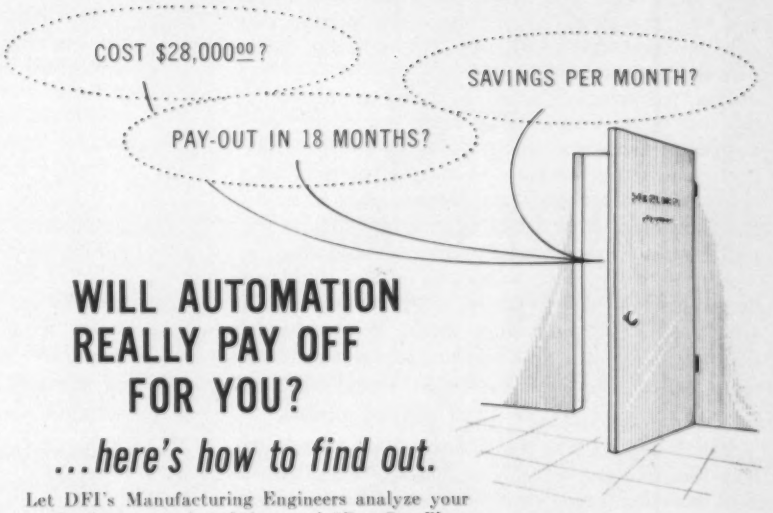

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Circle 662 on Page 35

CREATE THE PROPER CLIMATE

By Dr. J. G. HUTTON
General Manager, Specialty Control Dept.
Industrial Electronics Div.
General Electric Co.
Waynesboro, Va.

LIKE MANY companies, our automation planning began during the post-war period starting in 1946, though we probably didn't think of it actually in those terms. The war had created many pressures on all segments of society, and each of these would play a part in how and where industry would be led. As a result, it was a time for depth analysis and evaluation to prepare for the years ahead.

Examining our own situation in the light of this background, we saw a very bright future though not without its pitfalls. Probably the most important single factor we, as well as all industry, faced was the stepped up pace we could expect. Things were going to change much faster than ever before and this meant having the resources to cope with any situation that might develop in order to insure stable growth.

The technological breakthroughs stimulated by the war were recognized as being one of the most significant factors to affect industry. General Electric, particularly, because of its great diversification in terms of products, markets, and types of manufacturing faced a period of change of immense proportions.

At the same time, technology alone could not be the deciding factor in any long range decisions affecting the company as a whole. It was decided early, then, that we would have to provide a climate or company structure that would best encourage balanced growth in all areas of interest.

This began to take real form in 1953 when General Electric went through a major reorganization. The most significant change was in creating highly decentralized responsibility, accountability, and authority throughout all company components.

The product department, under a general manager, became the basic operating unit with all necessary functions to operate pretty much as an independent business. By reason of decentralized authority and responsibility, it was also impractical to consider automation in General Electric to be organized, directed, and administered by any central authority.

Each general manager, therefore, is charged with planning and implementing automation for his product department. Accomplishment in this area is one of the measurement criteria of his over-all effectiveness in developing the business.

Each product department operates on its own profit and loss and must automate within the capital investment funds which it generates. As a result, the extent of automation in General Electric is the sum total of the programs for each of these individual businesses. And, its automation capabilities compare directly with the average size industrial business.

However, the product department's size is a handicap in sustaining any very long range or great depth studies to provide for future needs. Furthermore, even if this were attempted, it would mean a lot of duplication and inefficiency for the company as a whole. In recognizing this shortcoming, a services organization was also established for each of the main operating functions found in the product department—manufacturing, engineering, marketing, and finance.

The services are charged with the responsibility for research, teaching, and as a clearinghouse for specialized information to provide all operating components with the most advanced knowledge in all functional fields. Thus, the relatively small departmental businesses can have the advantages of large company know-how in all functional areas.

Company management, seeing the potential of automation to General Electric, charged Manufacturing Services to proceed post-haste with the evaluation of automation techniques and equipment specifically as it could be applied to General Electric types of manufacturing. Thus, the manufacturing engineers in our product departments could look to the experts in Manufacturing Services for consultation and recommendations.

Areas of Endeavor

The following are examples of evaluation and development work done by our Manufacturing Services Laboratory which resulted in the purchase of new automated equipments by our product departments:

In 1959 a program was initiated to evaluate the capabilities of numerically controlled machine tools and encourage their use where advisable throughout manufacturing operations. An extensive survey was conducted first and data gathered and synthesized on all pertinent factors surrounding machining needs in the company. Following this, a Kearney and Trecker Milwaukee-Matic was purchased in order to compare how it would perform under

actual conditions and requirements as found in our various plants.

Once its own studies were completed, Manufacturing Services carried out a company-wide educational program including training sessions for selected people on the use and applicability of numerical control. Specific evaluations by product department and the type of machines best suited to their needs were also provided.

A similar evaluation and training project was conducted with a Wiedemann punch press equipped with a General Electric Mark II numerical positioning control. Here, the Manufacturing Services Laboratory also developed automatic loading and unloading equipment which was felt would be generally useful to operations where such a machine could be applied.

Another interesting project which is still in the process of development is an automatic programmed manipulator for the handling and assembly of small parts—a generally useful need throughout the Company.

Quality control is another area which has received much more attention in the last few years and one where automation offers great promise. One device developed here is an automatic relay tester with added capability in classifying by various quality levels. The classification feature has many applications where products must be graded before shipment and also provides statistical data on the manufacturing process as a means for its control and adjustment.

In furthering automation activities, however, Manufacturing Services is limited by the facts that: 1. Its interest is centered on production methods. 2. It is not designed to carry out projects for particular operating components but to provide a pool of advanced knowledge from which everyone can draw. As interest intensified, other means had to be found to fill the great opportunity for automation in engineering, data processing, production scheduling, inventory control, warehousing, and similar activities.

The alternatives would be for a product department to carry out a program by itself or engage outside sources for at least some part of the work. Both of these measures have been used and very successfully, but they can have disadvantages to the company if made too widespread a practice. Essentially, the disadvantages are that: 1. Product departments become encouraged to develop and support special skills without adequate utilization. 2. An inordinate use of outside sources could weaken over-all company strength by the loss of proprietary information.

As a result, some new steps were taken to provide for this situation. In 1959, an organization was established called the Internal Automation Operation and made an operating component of the Industrial Electronics Division. Its uniqueness lay in two areas: 1. The Internal Automation Operation, known as IAO, was staffed with people each having automation experience in at least one of the major business functions. 2. Its services would be provided on a fee basis to other components of the company.

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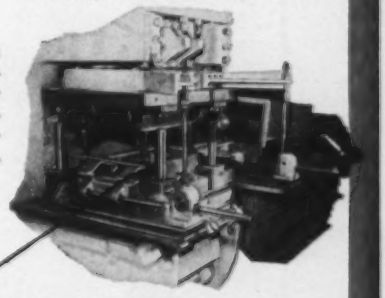

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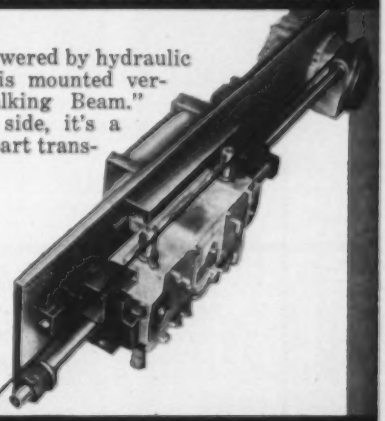

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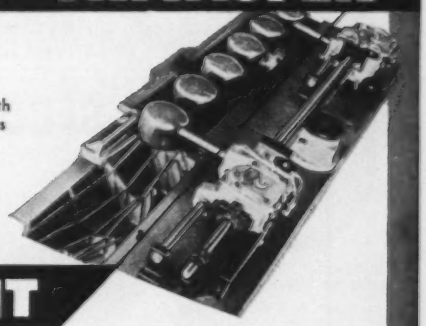

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Circle 738 on Page 35

Several benefits accrue from this arrangement. It recognizes that automation planning and execution require a depth of special skills and brings these to bear on the problem by a closely knit, highly specialized team. And, by having IAO work on a fee basis, it maintains freedom of action by operating departments to use the services offered as they see fit.

IAO does not pretend to have all the knowledge needed for successfully coping with all aspects of automation—especially as regards a specific project. One of its main purposes, however, is to effect integration of all automation resources, no matter where found, and to concentrate them on the job at hand.

The project is usually handled by a combined team of people from IAO and the operating component. In this manner, the operating people broaden their span of knowledge as well as become intimate with all details which are extremely necessary to guarantee that the project is followed through successfully.

In its short two-year existence, IAO has opened up tremendous opportunities for cost savings to General Electric product departments through automation of business processes. From the handful of product department feasibility studies completed thus far, estimated annual gross savings of over $5 million are evident. It is important to note that the major share of IAO's efforts have been directed to data processing and other information handling activities. Therefore, the savings mentioned do not include much of the great opportunity for savings in direct manufacturing.

The feasibility studies and recommendations have been so well received by product departments that IAO also plans to take on projects outside the company on a selective basis.

Looking at the results of all automation activities, we feel good progress has been made though there is still a long way to go. At this moment, throughout the General Electric Co., 95 program controlled automatic machines are now in use with an initial investment cost of $8 million.

Annual cost savings being realized from these machines are estimated in excess of $3 million. These figures include the machines at our Large Steam Turbine and Generator Department which we believe to be the largest single automated job shop in the world. At this department there are eight large special purpose numerically controlled machine tools being used to produce tailor-made parts for mammoth steam turbine-generator sets ranging in size up to half a million kilowatts.

More typical of the average General Electric product department is our plant at Waynesboro, Va. Our manufacturing operations are mainly wiring and component assembly with a minimum of machining. Our first purchase was a turret-type drilling machine with a two-motion positioning control. It has been in continuous two-shift use for three years drilling a variety of small metal parts and printed circuit boards. Our payback was achieved in the first year of operation.

Since we fabricate all of our metal enclosing cases, covering a wide variety of sizes, we had a natural application for a large numerically controlled punch press. Payback on this machine will be less than two years. To produce the tapes for the punch press, we designed another device, called the autoprogrammer, which eliminates the necessity of preparing outline drawings and considerably reduces our engineering work. Approximately a year ago we installed a Milwaukee-Matic machine. This machine is so flexible its value is only appreciated through use—every day we find new parts to add to this machine's schedule. Our present estimate of cost savings are manifold what we had originally anticipated.

Additional Opportunities

Apart from machining, another large opportunity for automated equipment is test and inspection work. We have built several programmed quality information and test systems which we are now using in our component and subassembly manufacturing operations. Several examples are:

1. An Automatic Transformer Tester which operates from either a punched tape program or manual pushbuttons.

2. Multicycle—used to identify early-life failure in an electrical system. Our best estimates indicate a field failure reduction in the order of 100 to 1 for some equipments with the testing performed in a tiny fraction of the time it would take manually.

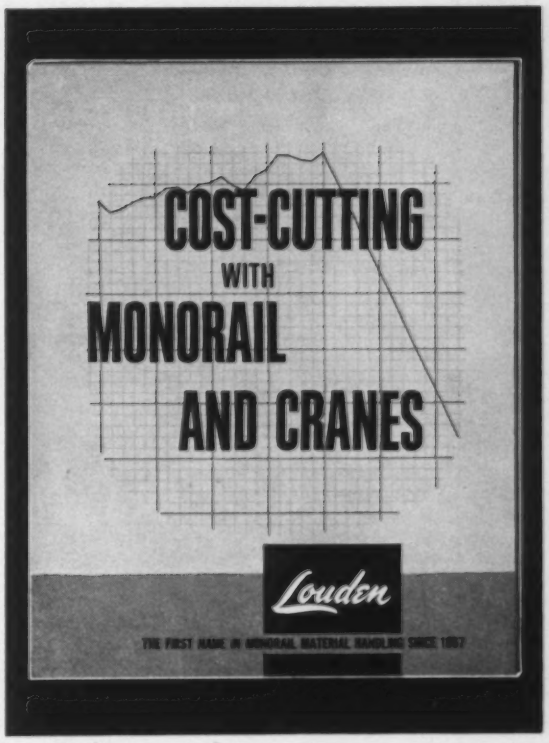
3. A Programmed Automatic Circuit Tester which in one operation can check up to 3600 wire ends for proper connection, missing wires, and extra wires. Further, it can type out a correct wiring table or produce a punched tape for testing identical units. Weeks of manual checking can be reduced to a few hours.

Our next project will be automation of our factory parts warehouse. To prove out feasibility and practicality of such automated material control, we have built a model program controlled order picking system which calls out material from warehouse stocks from an input carried on tabulating cards.

The major share of our production is of the small lot or job shop variety and we have found many ways to bring flexible automation to these manufacturing areas. Most of our automation progress has also resulted from "grass roots" initiative. Even where broad company resources have been put to use, such as with Manufacturing Services, similar capability is within the province of even small industrial firms in one form or another.

Automation techniques and equipment are on the market today ready to be put to use—ready to pay their own way. We firmly believe that the approach to automation is evolutionary—that all companies should start by taking advantage of opportunities to automate individual functions, processes or machines. The automatic factory will some day evolve from these islands of automation which are within the resource capabilities of all businesses.

From a paper entitled "Plans and Policies for Automation," presented at the Fifth Conference on Manufacturing Automation, Purdue University, Lafayette, Ind., April, 1961.



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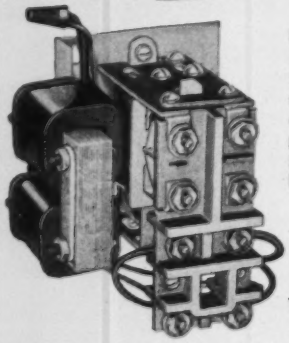

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ACCEPT AND EXPLOIT

By T. J. WATSON, JR.
President
IBM Corp.
New York, N. Y.

WE CAN'T ARGUE that technological change and automation are not labor-saving processes. Of course they are. They do cause displacement of people. In fact, to do so is one of their major purposes. They may also upgrade people or increase the prosperity of an industry so that more are employed.

There are three main approaches that we might take towards handling technological change and the unemployment it creates: 1. Retard it, and spare ourselves the pains of adjusting to it. 2. Let it come on, and take the benefit of it in increased leisure, spreading employment around by adopting a shorter work week. 3. Accept it fully, push it ahead with vigor, and exploit its benefits while controlling its hazards.

The first is a foolhardy approach. It amounts to saying that we shall reject progress because we don't know how to spread it equitably among all people. If we don't know how, we're going to have to learn how. We certainly can't stand still.

We are a nation of 180 million confronting, with our allies, hostile powers of roughly a billion. We cannot win out by force of numbers, but only by superior productivity per man. This is the real test of whether democracy can triumph over Communism. So it would seem that rapidly advancing technology is one of the major means we have of winning the Cold War against overwhelming numercial odds. Retarding it would be the same as undertaking unilateral disarmament.

The second possibility, the shorter work-week, is an equally undesirable solution. We cannot now afford increased leisure. It is in direct conflict with our national needs. We must find some other way to offset unemployment.

Only the third alternative, the acceptance of technological change, the acceleration of it—if possible—can fill our present needs.

We must try to solve the unemployment problem by putting it in the setting of the nation's problems as a whole. In this way we can accept the challenge of unemployment and convert it, through re-employment, into a source of increased national power.

We have many things that need doing. We need many new schools, new housing and slum clearance, dispersal of industry, and a system of fallout shelters against atomic attack. Increased armaments are probable and more missile activity a surety. We need to attract new industries to depressed areas. And we must keep our exports high by prices competitive in international markets.

Better education for all here at home requires more and better teachers and thousands of us must go overseas to win new friends for our country by showing our allies how to upgrade themselves. These are just a few of the things which must be done.

From a talk entitled "Automation and National Power," presented at the Western Joint Computer Conference, Los Angeles, May, 1961.

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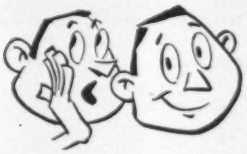


Problems concerning systems, equipment, or components for automated operations are invited. Submit to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solutions to problems are invited to submit them and should refer to problem title and case number.

PACKAGING HOSPITAL SUPPLIES **Case 2424-P**

. . . We are interested in developing an automatic packaging machine to package various hospital supplies in the Central Service Dept. Such a piece of equipment will be tied into products which we make, but we are at a loss as to whom to contact to be of assistance to us. One requirement is that it does not have to be a high-speed operation, but must be able to function to handle many various sized packages . . . Manager, Allied Products Dept.

WINDING RUBBER TAPE **Case 2427-P**

. . . We make a soft rubber tape by an extrusion process. As the tape comes from the extruder, we wind it into rolls. At the present time, we do this manually, and the operation is quite expensive. Do you know of anyone who could supply us with an automatic machine to wind this tape automatically? . . . Manager

HANDLING STEEL PIPE **Case 2429-P**

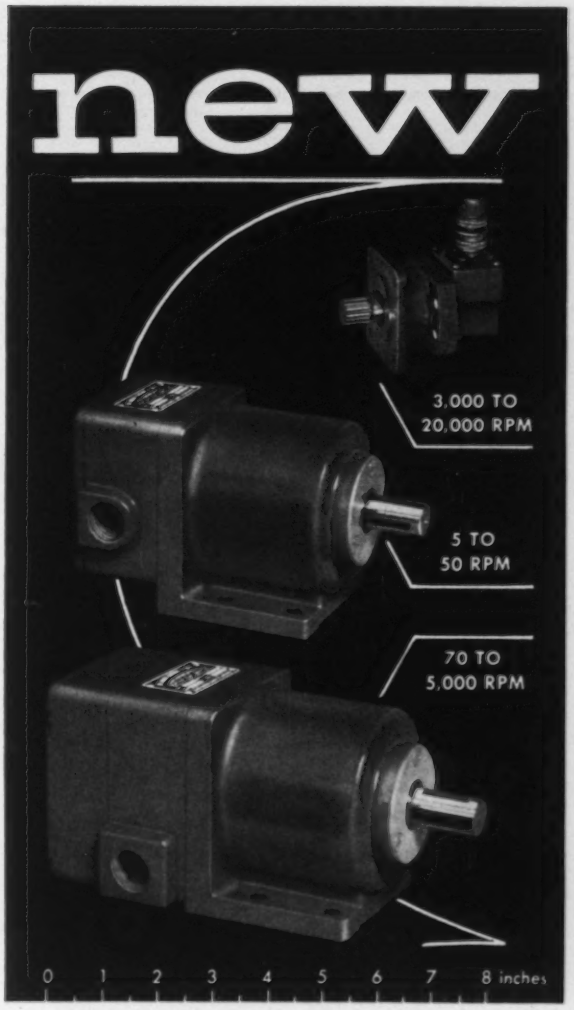
. . . We are concerned with handling pipe that is 4 to 20 inches in diameter and 60 feet in length. The pipe is steel and weighs between 17 and 80 pounds per foot. The pipe would be handled one length at a time with the pipe always in a horizontal position. The pipe would be transferred from one area to another 20 feet away . . . Chief Engineer

FEEDING STRINGY TOBACCO **Case 2430-P**

. . . We have developed a device which will take a stringy-type tobacco, having fibers in the 3 to 4 inch range and approximately 0.004 to 0.006 inch diameter, and diffuse them into a light fluffy blanket to accommodate existing weighing devices. The product simulates damp, matted hair when in the bulk condition. All efforts to successfully hopper feed this material have eluded us. We are looking for an automatic hopper feeding device that can handle this material at a continuous rate . . . Associate Engineer

SPREADING SHREDDED ASBESTOS **Case 2431-P**

. . . We wish to spread a dry shredded asbestos material on a cold platen which is 30 by 36 inches and has side rails approximately 3 inches high. This material is filled with various binder chemicals and has the consistency of shredded peat moss but is heavier and gritty. The process will start from a hopper holding about 3 cu yd of the material. A blanket of material is to be spread automatically to an even density and a depth of 3 inches. If the blanket is fed continuously by a conveyor, the cut off at the 36 inch dimension must be clean and square. Conveyors and other devices cannot use vibration as this causes segregation in the material. There are 4 platens to be fed, two on each press. Each press will operate on a 20 sec cycle, with about 6 sec allowed for loading . . . Engineer



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Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.

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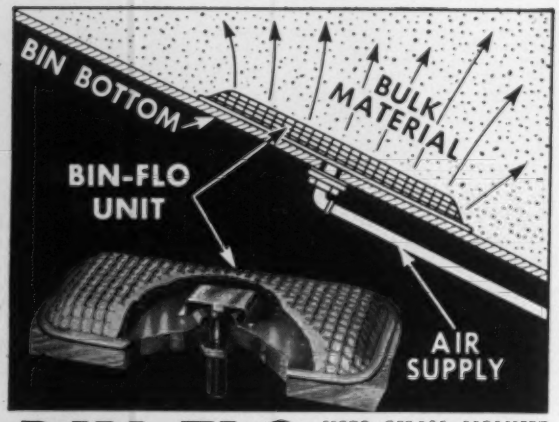

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Edited by board consisting of W. C. Michels, R. C. Hoyt, and J. R. Pruett, all of Bryn Mawr College and J. C. May, Yale University; second edition, 1355 pages, 7 by 10 inches, published by D. Van Nostrand Co. Inc., Princeton, N. J.; available from AUTOMATION; *$27.85 postpaid.*

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By R. A. Greiner, associate professor of electrical engineering, University of Wisconsin; 493 pages, 6 by 9 inches, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; *$12.50 postpaid.*

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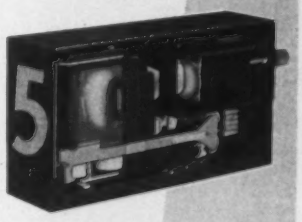

BINA-VIEW Self-Decoding Alpha-Numeric Readout

Applications: Connected directly into computers, teletype, etc.

Features: Electro-magnetic operation, low power (10 milliwatts), accepts BCD code to 6 bits, does own translating.

Specifications: 1⅜" high character, module size 1¾" x 3¼" x 6¾"

Price Complete from $50.00

WRITE TODAY FOR COMPLETE DETAILED INFORMATION

INDUSTRIAL ELECTRONIC ENGINEERS, Inc.
5528 VINELAND AVENUE
NORTH HOLLYWOOD, CALIF.
Representatives in principal cities.

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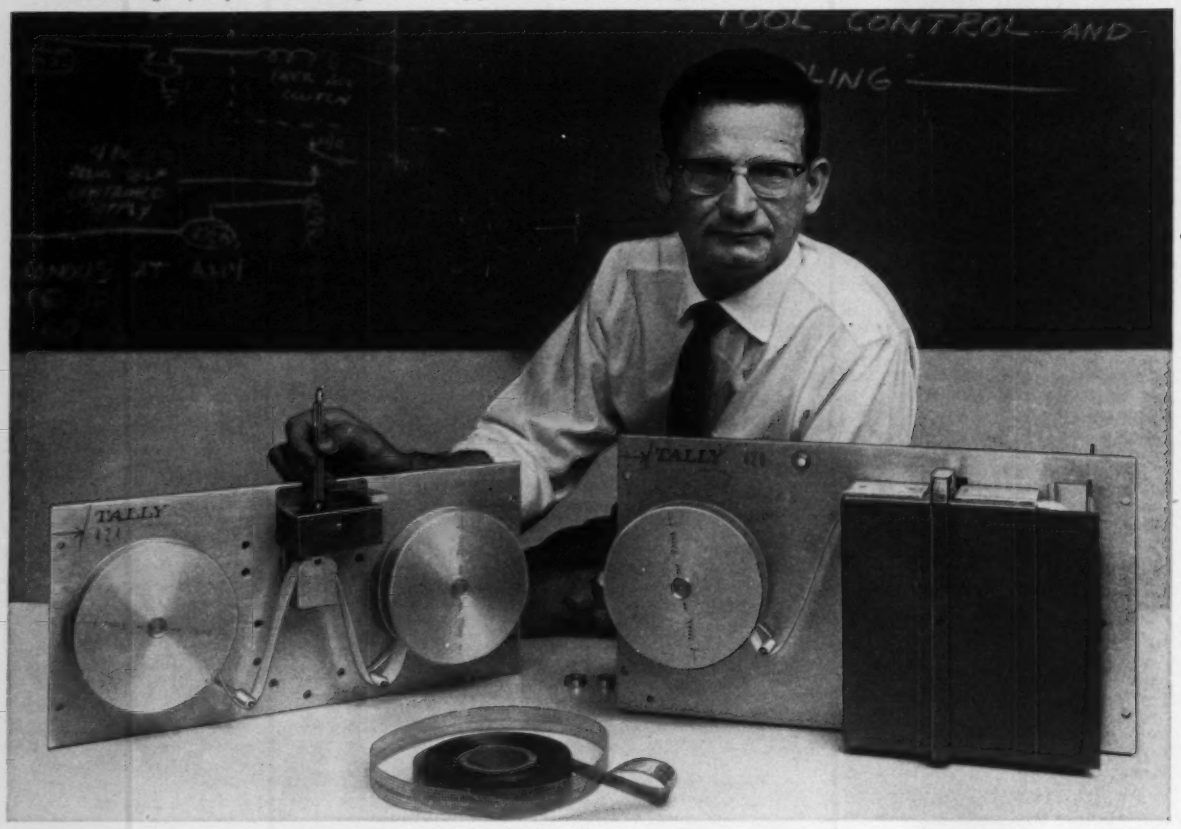
MANUFACTURERS' REPRESENTATIVES WANTED

Growing manufacturer of Rotary Type Limit Switches, Explosion-Proof Enclosures and Control Units, Terminal Blocks, Electronic Timers, Magnetic Timers and Custom Control Systems needs representatives in several areas. For further information, please send full particulars regarding experience, present lines and territory covered. Gemco Electric Company, 25685 West Eight Mile Road, Detroit 40, Michigan

Use an Inquiry Card

For further information on anything described or advertised in this issue . . . . . SEE Page 35

• *A message of importance to engineers using punched paper tape equipment for machine tool control & data handling*



WHY TALLY READERS AND PUNCHES TALK EASY

You can talk to Tally punched tape readers and perforators with less input and output logic than any other equipment on the market. You can talk to Tally equipment faster. With only one command, your Tally reader will read and advance; your Tally perforator, punch and advance. You can read or punch 5, 6, 7, or 8 channels without modification. Oil mist lubrication provides whisper quiet operation. Their engineered simplicity means long term reliability.

Tally perforators operate *asynchronously* at any rate up to 60 characters per second. Their unique wire clutch drive lets you vary speed for slaving to other equipment, simplifying design of logical systems. Prices for perforators start at $1,000.

P.S. Problems in making complex programming tapes? Call us, we're making 4 to 16 channel guaranteed error-free punched tapes for many missile and satellite programs.

...and long

Tally readers feature a reading rate of 60 characters per second in either direction, instantly reversible for rapid search and select. They have triggered tape feed readout with the rate controlled by external equipment. Full accountability is furnished by the Form C switch which provides positive hole/space sensing. Reader prices begin at $595.

Special Tape Systems Available

On request, Tally engineers will be happy to review your product requirements for special tape readers, perforators and reader-perforator systems. Please address Dept. 10

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1310 Mercer Street
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7

Circle 746 on Page 35

NEW...from RCA

The best designed AIR GAGE ever offered!

COMPARE THESE OUTSTANDING FEATURES!

- Four ranges of adjustable magnification are provided with 10" linear scale.
- Tube is spring-loaded with positive seal to provide for simple change and removal.
- Captive float cannot drop out when tube is removed.
- Four spare tubes and scales can be stored internally in the column.
- Modular design permits flexibility in grouping units with minimum space.
- Complete range of tooling is available for gage use.

No other air gage on the market can match the ease and compactness with which these RCA units can be grouped into multiple systems . . . expanded at will at minimum cost. Their attractive functional design with this built-in expansion feature is certain to be a welcome innovation to all users of such equipment.

RCA offers these Air Gages as single or multiple units for bench-type operation or as components of automatic systems. A complete range of tooling is also available for all types of measurements normally performed with this equipment.

RCA also manufactures Industrial Computers and Controls, and a complete line of Electronic Gaging Systems, Grinder Controls, Automatic and Bench-type Hardness Testers, Parts Feeding and Assembly Systems and Electronic Comparators. Whatever your automation requirements, RCA offers the most versatile range of equipment available.

Before you buy Air Gaging, Check RCA. Write to RCA, Industrial Controls, Dept. Y-350, 12605 Arnold Avenue, Detroit, Mich., or see your RCA Representative.

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The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

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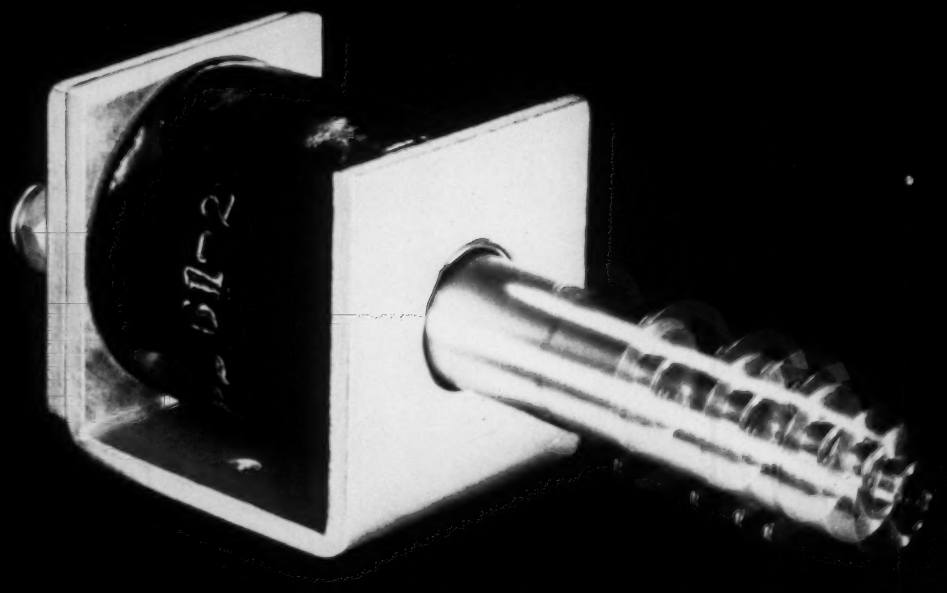
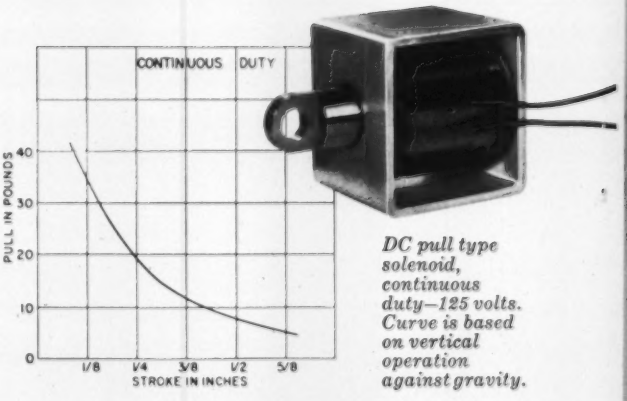
100 MILLION OPERATIONS!



new ASCO solenoid has virtually unlimited life . . . outstanding economy

In this case "unlimited life" is a simple statement of fact. ASCO's new solenoid is manufactured to such precise tolerances (±0.0005") that wear is virtually non-existent. In ordinary solenoids, the plunger rides loosely in the sleeve—inviting wear. But in ASCO's long-life solenoid, the plunger is guided by a machine tool bearing that assures accurate stroking and reduces friction to an absolute minimum.

Because this solenoid was engineered with quality as the prime consideration, its initial cost is higher. However, it is in fact *the most economical solenoid you can buy* because, once installed, it can practically be forgotten. This solenoid will still be functioning 100 million operations later—long after standard types have been replaced—and replaced—and replaced. For additional information, contact your ASCO engineer or write for Catalog 57-S5.



DC pull type solenoid, continuous duty—125 volts. Curve is based on vertical operation against gravity.

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